

Savina

Intensive Care Ventilator

Operating Instructions
Software 1.n





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How to Work With These Operating Instructions

The header line...

contains the main chapter title

to help you quickly find your way around in the manual.

The page body...

contains the instructions for use

in a combination of text and illustrations. The information is expressed directly in terms of actions, enabling users to familiarize themselves with the operation of the ventilator by hands-on activities.

The left-hand column...

contains text

which provides explanations and guides the user with brief and clear instructions in an ergonomic sequence for confusion free use of the ventilator.

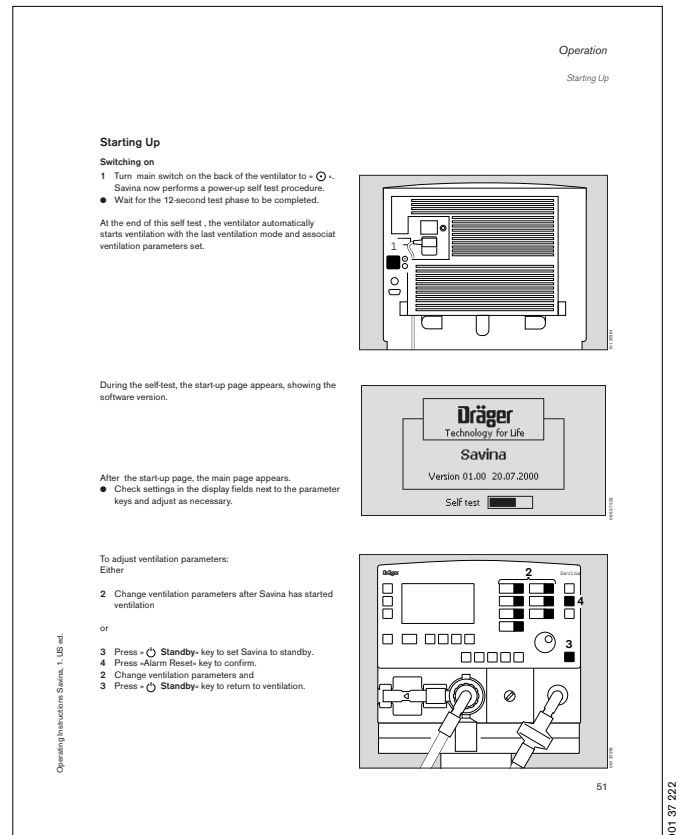
Bullet points indicate steps of actions. In many cases, numbers are used to highlight the relation between the step described in the sequence of operations and the associated illustration(s).

The right-hand column...

contains illustration(s)

relating directly to the facing text column and shows users where to find the elements mentioned in the text. Non-essentials are omitted.

Renderings of ventilator screen images guide the user and allow to reconfirm steps of actions to be performed.



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Contents

Important Safety Information READ THIS FIRST! Safety considerations	7
Intended Use Areas of use, restrictions of use, appropriate monitoring, back-up ventilation	17
Operating Concept Controls, parameter setting, screen structure	21
Preparation Assembly, installation, checks of readiness for operation	29
Operation Ventilation modes, alarm limits and alarm priorities, waveforms, measured values, special functions	49
Configuration Contrast, volume, measured value bar, language, apnea ventilation ON/OFF	77
Care Dismantling, cleaning, disinfecting, sterilizing	85
Maintenance Maintenance intervals, user replaceable parts, disposal	93
Troubleshooting Fault analysis and correction chart	101
What's What Overview, labels, abbreviations, symbols	111
Technical Data Ambient conditions, performance characteristics, operating characteristics, classifications, materials	119
Theory of Operation Description of ventilation modes	127
Ordering Information Part numbers, consumables	137
Index	140

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Important Safety Information READ THIS FIRST!

Operator's Responsibility for Patient Safety 8

Limitation of Liability 8

Warranty 9

Definitions 10

Summary of WARNINGS and CAUTIONS 11

Important Safety Information

Operator's Responsibility for Patient Safety

For correct and effective use of the product and in order to avoid hazards it is mandatory to carefully read and to observe all portions of this manual.

The design of the equipment, the accompanying literature, and the labeling on the equipment take into consideration that the purchase and use of the equipment are restricted to trained professionals, and that certain inherent characteristics of the equipment are known to the trained operator. Instructions, warnings, and caution statements are limited, therefore, largely to the specifics of the Dräger design.

This publication excludes references to various hazards which are obvious to a medical professional and operator of this equipment, to the consequences of product misuse, and to potentially adverse effects in patients with abnormal conditions. Product modification or misuse can be dangerous. Draeger Medical, Inc. disclaims all liability for the consequences of product alterations or modifications, as well as for the consequences which might result from the combination of this product with other products whether supplied by Dräger or by other manufacturers if such a combination is not endorsed by Draeger Medical, Inc.

Patient monitoring

The operators of the ventilator system must recognize their responsibility for choosing appropriate safety monitoring that supplies adequate information on equipment performance and patient condition. Patient safety may be achieved through a wide variety of different means ranging from electronic surveillance of equipment performance and patient condition to simple, direct observation of clinical signs. The responsibility for the selection of the best level of patient monitoring lies solely with the equipment operator.

Limitation of Liability

Draeger Medical, Inc.'s liability, whether arising out of or related to manufacture and sale of the goods, their installation, demonstration, sales representation, use, performance, or otherwise, including any liability based upon Draeger Medical, Inc.'s Product Warranty, is subject to and limited to the exclusive terms and conditions as set forth, whether based upon breach of warranty or any other cause of action whatsoever, regardless of any fault attributable to Draeger Medical, Inc. and regardless of the form of action (including, without limitation, breach of warranty, negligence, strict liability, or otherwise).

THE STATED EXPRESSED WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR NONINFRINGEMENT.

Draeger Medical, Inc. shall not be liable for, nor shall buyer be entitled to recover any special incidental, or consequential damages or for any liability incurred by buyer to any third party in any way arising out of or relating to the goods.

Warranty

All Dräger products are guaranteed to be free of defects for a period of one year from date of delivery.

The following are exceptions to this warranty:

1. The defect shall be a result of workmanship or material. Defects caused by misuse, mishandling, tampering, or by modifications not authorized by Draeger Medical, Inc. or its representatives are not covered.
 2. Rubber and plastic components and materials are warranted to be free of defects at time of delivery.
- Any product which proves to be defective in workmanship or material will be replaced, credited, or repaired with Draeger Medical, Inc. holding the option. Draeger Medical, Inc. is not responsible for deterioration, wear, or abuse. In any case, Draeger Medical, Inc. will not be liable beyond the original selling price.

Application of this warranty is subject to the following conditions:

1. Draeger Medical, Inc. or its authorized representative must be promptly notified, in writing, upon detection of the defective material or equipment.
2. Defective material or equipment must be returned, shipping prepaid, to Dräger or its authorized representative.
3. Examination by Dräger or its authorized representative must confirm that the defect is covered by the terms of this warranty.
4. Notification in writing, of defective material or equipment must be received by Dräger or its authorized representative no later than two (2) weeks following expiration of this warranty.

The above is the sole warranty provided by Draeger Medical, Inc. No other warranty expressed or implied is intended. Representatives of Dräger are not authorized to modify the terms of this warranty.

Draeger Medical, Inc., Telford, PA

Definitions

WARNING !

A **WARNING** statement refers to conditions with a possibility of personal injury if disregarded.

CAUTION !

A **CAUTION** statement designates the possibility of damage to equipment if disregarded.

NOTE: A **NOTE** provides additional information intended to avoid inconveniences during operation.

Inspection	examination of actual condition
Service	measures to maintain specified condition
Repair	measures to restore specified condition
Maintenance	inspection, service, and repair, where necessary
Preventive Maintenance	maintenance measures at regular intervals

Typing conventions in this manual

Display messages are printed in bold, e. g:

!!! Fail to cycle

Screen keys and other controls are indicated as »**Control**«, e.g:

»**Standby**«

Abbreviations and Symbols

Please refer to “Abbreviations” on page 116 and “Symbols” on page 118 for explanations.

Labels on the equipment

Please refer to “Labels” on page 115

Summary of WARNINGS and CAUTIONS

General WARNINGS and CAUTIONS

WARNING !

Strictly follow this Operator's Instruction Manual !
Any use of the product requires full understanding and strict observation of all portions of these instructions. The equipment is only to be used for the purpose specified under "Intended Use" (see page 18). Observe all WARNINGS and CAUTIONS as rendered throughout this manual and on labels on the equipment.

WARNING !

The Savina ventilator must only be used under the supervision of qualified medical personnel in order to provide immediate corrective action in case of a malfunction.

WARNING !

This device is to be used only in rooms with line power installations complying with national safety standards for hospital patient rooms. (e.g., IEC 601.1, "Safety of Medical Equipment).
To maintain grounding integrity, connect only to a "hospital grade" receptacle. Always disconnect supply before servicing.

WARNING !

DANGER, risk of explosion if used in the presence of flammable gases or anesthetics.
This device is neither approved nor certified for use in areas where combustible or explosive gas mixtures are likely.

WARNING !

Do not use mobile phones within 33 feet (10 m) of the equipment.
Wireless phones may cause failure in electromedical equipment.

WARNING !

Do not use in conjunction with nuclear spin tomography (MRT, NMR, or NMI)!
Equipment malfunction may result.

WARNING !

Do not use the Savina ventilator in hyperbaric chambers. Equipment malfunction may result, with the risk of patient injury.

WARNING !

Avoid pollutants in the ambient air.
Savina uses ambient air for ventilation and pollutants would enter the patient's airways.

WARNING !

In case of malfunction of any of the built-in monitoring, a substitute must be provided in order to maintain an adequate level of monitoring. The operator of the ventilator system must still assume full responsibility for proper ventilation and patient safety in all situations.

WARNING !

Back-up ventilation with an independent manual ventilation device

If a fault is detected in the Savina so that its life-support functions are no longer assured:

- start ventilation using an independent ventilation device (resuscitation bag) without delay, if necessary with PEEP and / or increased inspiratory O₂ concentration.

WARNING !

The functioning of this machine may be adversely affected by the operation of equipment, such as high frequency surgical (diathermy) equipment, defibrillators or short-wave therapy equipment in the vicinity.

CAUTION ! **Restriction of Distribution**

Federal Law and Regulations in the United States and Canada restrict this device to sale by or on the order of a physician.
Device for use in health care facilities only and exclusively by persons with specific training and experience in its use.

Precautions during preparation

WARNING!

Do not place containers of liquids (such as infusion bottles) on top of or above the Savina ventilator. Liquids getting into the ventilator can cause equipment malfunction with the risk of patient injury.

WARNING!

Always use components that have been properly cleaned and disinfected.

WARNING!

Always use bacteria filter on the inspiratory port of the ventilator.

WARNING!

Draeger cannot warrant or endorse the safe performance of heat/moisture exchangers with the Savina ventilator. The user has to verify that the heat/moisture exchanger is covered by a technical safety certificate which guarantees its complete suitability for its intended use.
Do not use a heat/moisture exchanger simultaneously with a nebulizer or heated humidifier!
Risk of increased breathing resistance due to condensation.

WARNING!

The flow resistance of bacteria filters placed in the expiratory side may be substantially increased by nebulized aerosols with the risk of impaired ventilation. If an expiratory filter is used during nebulization, airway pressures and flow should be monitored for any indication of increased expiratory resistance due to filter obstruction.

WARNING!

Draeger cannot warrant or endorse the safe performance of third party humidifiers for use with the Savina ventilator. Specifically, the user has to assess the risks of delivery of breathing gas not maintained at a proper temperature associated with different humidifier designs. It is strongly recommended to use the electronic temperature monitoring feature of the ventilator if no proximal airway temperature monitoring is performed by the humidifier used.

Increased pneumatic resistance in the inspiratory line caused by a humidifier may result in less accurate airway pressure readings.

We recommend contacting the manufacturers/ distributors of third party humidifier devices about compliance of their products with the requested performance characteristics.

WARNING!

Do not use a heat/moisture exchanger (HME) simultaneously with a heated humidifier!
Risk of increased breathing resistance due to condensation.

WARNING!

In order to avoid any risk of electric shock in the event of faulty grounding of patient monitoring equipment, do not use antistatic or electrically conductive patient circuits.

WARNING!

Do not use inspiratory circuits with a total length of less than 1.1 m (3.6 feet) between humidifier and wye.
Otherwise risk of excessive breathing gas temperatures!

WARNING !

Do not use humidifiers without temperature regulation.
Otherwise risk of excessive breathing gas temperature!

WARNING !

This device is to be used only in rooms with line power installations complying with national safety standards for hospital patient rooms. (e.g., IEC 601.1, "Safety of Medical Equipment).
To maintain grounding integrity, connect only to a "hospital grade" receptacle. Always disconnect supply before servicing.

WARNING !

Connecting other devices to the same extension power strip may, in the event of grounding failure, cause the leakage current to the patient to increase beyond the permissible values.
In this case, the risk of electric shock cannot be safely excluded.

WARNING !

Use rechargeable batteries **ONLY**.

Because of the charging feature of the Savina DC power supply, connecting non-rechargeable batteries might lead to a risk of explosion when operating the ventilator from line power.

WARNING !

Leave Savina connected to AC line power only in well ventilated rooms (air circulation: minimal 1.2 m³/h). Charging batteries generates hydrogen that, with sufficient concentration, could cause an explosion with the risk of personal injury.

WARNING !

Always use medical grade oxygen that is dry and free from contaminations. Contaminated gas may cause ventilator malfunction.

WARNING !

The ventilator is ready for operation only when:

- it is completely assembled with all required auxiliary equipment in place,
- all sensors are calibrated (O₂, Flow)
- all tests of readiness for operation have been completed successfully.

WARNING !

- Installation of the Savina nurse call kit should only be performed by DraegerService or factory trained and authorized service personnel.

WARNING !

The operator of the ventilator must still assume full responsibility for ventilation monitoring via the Savina screen when the nurse call is connected.
Only warning messages (!!!), i. e. alarm messages with top priority, will activate the nurse call.
● Regularly check on-screen messages.

WARNING !

A fault within any component of the combination between the nurse call and the central alarm system of the hospital (e. g. inside the Savina nurse call electronics, the Savina power supply or the hospital alarm equipment) may result in a failure of a proper nurse call function.

WARNING !

Do not use ventilator if the tests are not completed successfully.

CAUTION !

Do not connect AC/DC power supplies to the DC input.

Precautions during operation

WARNING !

Always use ventilator that has been cleaned and disinfected and has been successfully tested to be ready for operation.

WARNING !

In case of a fault in any of the built-in monitoring a substitute has to be provided in order to maintain an adequate level of monitoring. The operator of the ventilator must still assume full responsibility for proper ventilation and patient safety in all situations.

WARNING !

If a fault is detected in the ventilator and its life-support functions are in doubt, ventilation must be started without delay with an independent ventilation device (resuscitation bag) - using PEEP and/or increased inspiratory O₂ concentration where necessary and appropriate. The unit should then be removed from use and serviced by an authorized service technician.

WARNING !

- Always use extreme caution when using oxygen!
- Oxygen intensely supports any burning!
No smoking, no open fire in areas where oxygen is in use!
- Always provide adequate ventilation in order to maintain ambient O₂ concentrations < 24 %.
- Always secure O₂ cylinders against tipping, do not expose to extreme heat.
- Do not use oil or grease on O₂ equipment such as tank valves or pressure regulators.
Do not touch with oily hands. Risk of fire!
- Open and close valves slowly, with smooth turns.
Do not use any tools.

WARNING !

Always heed all precautions and follow all hospital protocols with respect to the administration of oxygen. Make adjustments to the FiO₂ according to the blood gas values measured.

WARNING !

Do not block air intake. Ventilator malfunction will result.

WARNING!

Do not place containers of liquids (such as infusion bottles) on top of or above the Savina ventilator. Liquids getting into the ventilator can cause equipment malfunction with the risk of patient injury.

WARNING !

Warning or Caution level audible alarms require immediate operator attention to avert or to prevent development of situations with the possibility of patient injury.

WARNING !

The alarm silence key is intended to provide a way of muting audible alarms while corrective action is taken. The operator of the ventilator must still assume responsibility for proper ventilation and patient safety in the event of an alarm. Failure to identify and correct alarm situations may result in patient injury.

WARNING !

In the event of a failure of the turbine blower, Savina is not able to continue ventilation. Immediately continue ventilation using an independent manual ventilation device (resuscitation bag) in this case.

WARNING !

Never use flammable medications (e.g. on the basis of ethanol). Fire hazard!

WARNING !

Since Savina uses pure oxygen for nebulizing medicated aerosols, an increase of the set inspiratory O₂ concentration may be caused.

WARNING !

The integrated nebulizer function of Savina is designed for nebulizers with a nebulizing flow of 6 L/min at 29 psi (2 bar), for example nebulizer 84 12 935 (white central body). Use of other pneumatic nebulizers may result in considerable discrepancies in the minute-volume reading!

WARNING !

Always use a reliable independent O₂ supply during calibration. In case the calibration procedure is based on a diluted oxygen source, Savina may deliver inaccurate oxygen concentrations without further notification.

WARNING !

Consider effects of aerosols on sensors, filters, and heat and moisture exchangers (HMEs)!
The measuring function of the flow sensor may be impaired.
The flow resistance of filters is liable to increase and may impair ventilation.
Do not put a microbial filter on the nebulizer outlet when in use!

WARNING !

Do not use a heat/moisture exchanger simultaneously with a nebulizer or heated humidifier!
Risk of increased breathing resistance due to condensation.

WARNING !

Always pay special attention to the success of a flow calibration. The operator of the ventilator must still assume responsibility for proper ventilation and patient safety in the event of a loss of expiratory flow monitoring. Replace a faulty flow sensor as soon as possible.

Precautions during configuration

WARNING !

Always adjust audible alarm volume to a level that ensures the operator will be alerted when alarms occur. Failure to identify and correct alarm situations may result in patient injury.

WARNING !

In case of a fault in any of the built-in monitoring a substitute has to be provided in order to maintain an adequate level of monitoring. The operator of the ventilator must still assume full responsibility for proper ventilation and patient safety in all situations.

Precautions during care procedures

WARNING !

Always use ventilator that has been cleaned and disinfected and has been successfully tested to be ready for operation.

WARNING !

Always follow accepted hospital procedures for handling equipment contaminated with body fluids.

WARNING !

Follow all accepted hospital procedures for disinfecting parts contaminated by body fluids (protective clothing, eyewear, etc.).

WARNING !

Vent flow sensor after disinfection with ethanol for at least 30 minutes or rinse with sterile water. Otherwise, residual ethanol vapors might ignite and destroy the sensor during calibration.

CAUTION !

Sterilisation of parts in ethylene oxide (EtO) may lead to a patient health risk:
Patients may become exposed to EtO that may have diffused into components.

CAUTION !

When removing a reusable patient circuit, always grasp hoses by their sleeve, never by the hose itself, to avoid possibly tearing the hose at the sleeve or ripping it out of the sleeve.

CAUTION !

Flow sensor is not compatible with parts washer equipment and may not be autoclaved or steam-sterilized. It cannot withstand high temperatures and would be destroyed.

CAUTION !

Do not disassemble expiratory valve beyond removing diaphragm!

Important Safety Information

Summary of WARNINGS and CAUTIONS

CAUTION !

Certain components of the ventilator consist of materials that are sensitive to certain organic solvents sometimes used for cleaning and disinfecting (e.g., alkylamines, phenols, halogen releasing compounds, oxygen releasing compounds, strong organic acids, etc.). Exposure to such substances may cause damage that is not always immediately recognized.

CAUTION !

Never operate the ventilator without a microfilter at the air intake. The inspiratory side of the ventilator and patient circuit would become dirty.

CAUTION !

The device must be inspected and serviced at regular intervals. A record must be kept on this preventive maintenance. We recommend obtaining a service contract with DraegerService through your vendor. For repairs we recommend that you contact DraegerService.

Precautions during maintenance

WARNING !

To avoid any risk of infection, clean and disinfect ventilator and accessories before any maintenance according to established hospital procedures - this applies also when returning ventilators or parts for repair.

WARNING !

Never operate the ventilator if it has suffered physical damage or does not seem to operate properly. We recommend that you contact DraegerService for maintenance service for the Savina Ventilator.

WARNING !

Treatment of batteries and O₂-sensor capsules:
Do not throw into fire! Risk of explosion.
Do not force open! Danger of bodily injury.
Follow all local, state, and federal regulations with respect to environmental protection when disposing of batteries and O₂-sensor capsules.

WARNING !

When servicing the ventilator, always use replacement parts that are qualified to Draeger standards. Draeger cannot warrant or endorse the safe performance of third party replacement parts for use with the Savina ventilator.

WARNING !

Both breathing and cooling air are drawn in through the filter cover.
Do not block air intake, do not place ventilator immediately against a wall – risk of overheating the ventilator.

Intended Use

Intended Medical Applications 18

Intended Areas of Use 18

Restrictions of Use 18

Appropriate Monitoring 19

Intended Use

Intended Medical Applications

Intended Areas of Use

Restrictions of Use

Intended Use

Intended Medical Applications

Savina®*

Long-term ventilator for intensive care.

For patients requiring tidal volumes starting at 50 mL.

With the following ventilation modes

CMV

Continuous Mandatory Ventilation

controlled and assisted constant-volume ventilation with intermittent (IPPV) or continuous (CPPV) positive airway pressure.

With the options:

CMV_{Assist}

Assisted ventilation with continuous positive airway pressure.

IRV

Inversed Ratio Ventilation

PLV

Pressure Limited Ventilation

AutoFlow® (optional)

for the automatic optimization of inspiratory flow.

SIMV

Synchronized Intermittent Mandatory Ventilation

Ventilation mode for weaning patients off the ventilator after they have started breathing spontaneously.

With the options:

PLV

Pressure Limited Ventilation

AutoFlow® (optional)

for the automatic optimization of inspiratory flow.

CPAP

Continuous Positive Airway Pressure

Spontaneous breathing with positive airway pressure.

SB

Spontaneous Breathing

Spontaneous breathing.

PSV

Pressure Support Ventilation

Pressure-assisted spontaneous breathing.

PCV+ (optional)

(Pressure Controlled Ventilation plus) (BIPAP**)

Pressure-controlled ventilation combined with free spontaneous breathing during the whole breathing cycle, and with an adjustable pressure assist starting on CPAP level.

Special modes:

Apnea Ventilation

For switching over automatically to volume-controlled mandatory ventilation, if breathing stops.

With monitoring for

- airway pressure, Paw
- expiratory minute volume, MV
- inspiratory O₂ concentration, FiO₂
- inspiratory breathing gas temperature, T
- apnea
- tachypnea monitoring to detect rapid, shallow spontaneous breathing

Intended Areas of Use

- In the Intensive Care ward or in the recovery room
- during secondary transport from one hospital to another
- during transfer of ventilated patients within the hospital

Restrictions of Use

WARNING !

The Savina ventilator must only be used under the supervision of qualified medical personnel in order to provide immediate corrective action in case of a malfunction.

* Savina® is a registered trade mark of Dräger Medizintechnik GmbH

** Licensed trade mark

WARNING !

This device is to be used only in rooms with line power installations complying with national safety standards for hospital patient rooms. (e.g., IEC 601.1, "Safety of Medical Equipment).

To maintain grounding integrity, connect only to a "hospital grade" receptacle. Always disconnect supply before servicing.

WARNING !

DANGER, risk of explosion if used in the presence of flammable gases or anesthetics.

This device is neither approved nor certified for use in areas where combustible or explosive gas mixtures are likely.

WARNING !

Do not use mobile phones within 33 feet (10 m) of the equipment.

Wireless phones may cause failure in electromedical equipment with the risk of patient injury¹

WARNING !

Do not use in conjunction with nuclear spin tomography (MRT, NMR, or NMI)!

Equipment malfunction may result.

WARNING !

Do not use the Savina ventilator in hyperbaric chambers. Equipment malfunction may result, with the risk of patient injury.

WARNING !

Avoid pollutants in the ambient air. Savina uses ambient air for ventilation and pollutants would enter the patient's airways.

Appropriate Monitoring

The built-in monitoring features of the Savina ventilator ensure appropriate monitoring of ventilation therapy and therefore detect any undesirable changes in the following ventilation parameters:

- airway pressure, Paw
- expiratory minute volume, MV
- inspiratory O₂ concentration, FiO₂
- inspiratory breathing gas temperature, T
- apnea
- tachypnea

Changes in these parameters may be caused by:

- acute changes in the patient's condition
- incorrect settings and user error
- equipment fault conditions
- failure of power and gas supplies

WARNING !

In case of malfunction of any of the built-in monitoring, a substitute must be provided in order to maintain an adequate level of monitoring. The operator of the ventilator system must still assume full responsibility for proper ventilation and patient safety in all situations.

WARNING !

Back-up ventilation with an independent manual ventilation device

If a fault is detected in the Savina so that its life-support functions are no longer assured:

- start ventilation using an independent ventilation device (resuscitation bag) without delay, if necessary with PEEP and / or increased inspiratory O₂ concentration.

* Dräger medical equipment fulfills the interference resistance requirements according to the product-specific standards or EN 60601-1-2 (IEC 601-1-2). However, depending on the design of the mobile phone and circumstances of use, field strengths may occur in the immediate environment of a mobile phone that exceed the limits of the above standards and therefore cause interference.

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Operating Concept

Ventilation Controls	22
Setting Ventilation Parameters	22
Selecting the Ventilation Mode	22
Screen Operating Controls	23
Keys for Routine and Auxiliary Functions	24
On Screen Information Window	24
Power Switch	24
Screen Pages	25
Structure of the screen pages	25
»Standby« Key	27

Operating Concept

Ventilation Controls

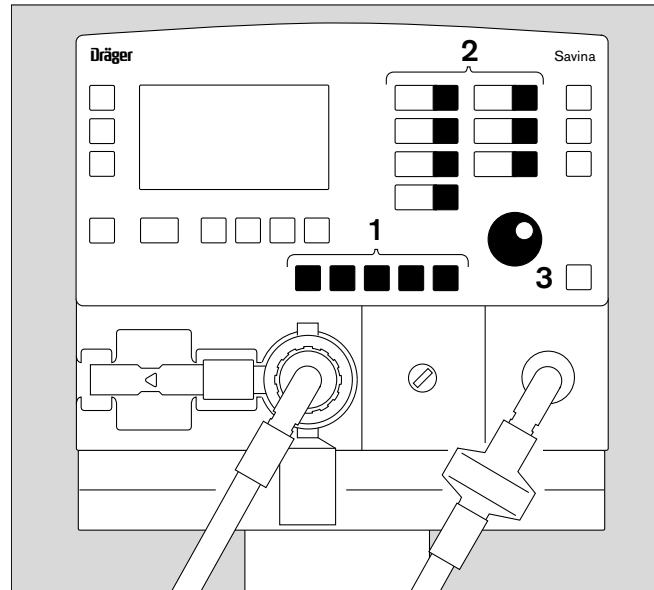
Setting Ventilation Parameters

Selecting the Ventilation Mode

Operating Concept

Ventilation Controls

- 1 Keys for selecting the ventilation modes:
 - **CMV A/C**
 - **SIMV**
 - **CPAP/PS**
 - **PCV+**
- 2 Keys for selecting / setting ventilation parameters:
 - Tidal volume **V_T**
 - Inspiration time **T_{insp}**
 - Frequency **Rate**
 - O₂-concentration **O₂**
 - Inspiratory pressure **P_{insp}**
 - Pressure support **ΔP_{supp}**
 - Positive End-Expiratory Pressure **PEEP**
- 3 Central "turn and push" rotary dial knob for setting parameters and for selecting screen parameters.
To set, turn dial knob
To confirm setting, press dial knob.



Setting Ventilation Parameters

- 2 To select a ventilation parameter, press the respective parameter key.
The yellow LED in the key lights up.
- 3 To set value of a ventilation parameter, turn dial knob.
The value is displayed next to the parameter key.
- 3 To confirm value, press dial knob.
The yellow LED in the key goes out.

NOTE: A new parameter value only becomes effective upon confirmation.

Derived parameters are displayed in an information window on the main screen page during the setting procedure.

Selecting the Ventilation Mode

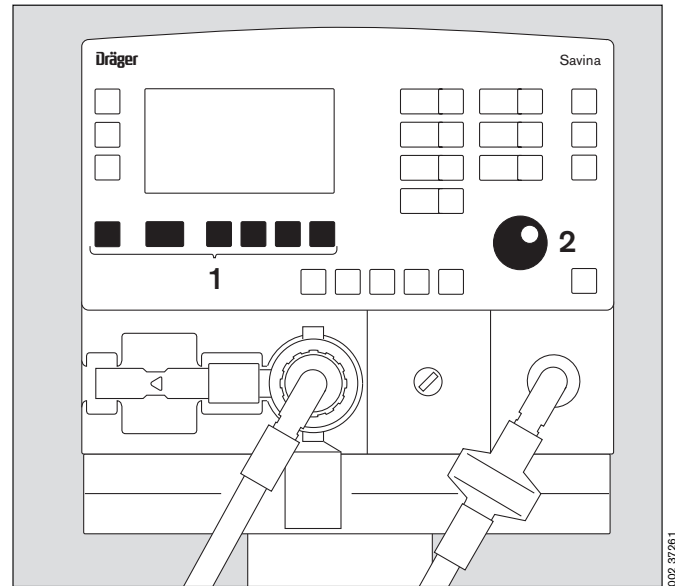
- 1 Hold down the appropriate key for about 3 seconds
or
- press key briefly and
- 3 confirm by pressing dial knob
The selected ventilation mode will now be activated.

For detailed instructions on setting ventilation modes, see page 52 and following.

Screen Operating Controls

1 Screen operating keys:

- »☀/●« key for setting screen and display brightness (bright or dim),
- »Waveforms ▲■▼« key for selecting the main screen page to display pressure and flow waveforms,
- »Settings ▢▢« key for selecting the "Setting" screen page in order to set other ventilation parameters,
- »Alarms ▢▢« key for selecting the "Alarms" screen pages in order to set and display alarm limits,
- »Values ▢▢« key for selecting the "Measured values" screen page in order to display measured values,
- »Config. ▢▢« key for selecting the "Configuration" screen page, for system defaults such as alarm volume or screen brightness.



2 Central "turn and push" rotary dial knob for selecting and setting the options displayed on the screen.

Select/set by turning dial knob
To confirm, press dial knob

Changing screen pages

To change to the next page:

- press the same key again.

To change to another page:

- press the respective key.

To change to the main page for pressure waveforms:

- press »Waveforms ▲■▼« key.



Operating Concept

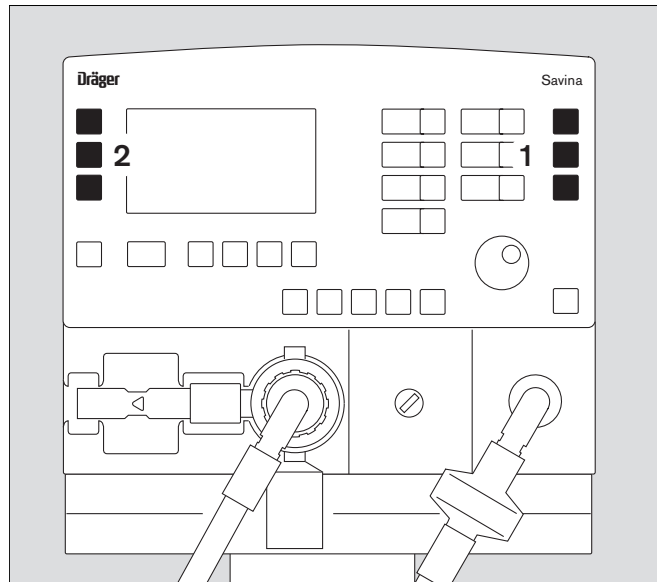
Keys for Routine and Auxiliary Functions

On Screen Information Window

Power Switch

Keys for Routine and Auxiliary Functions

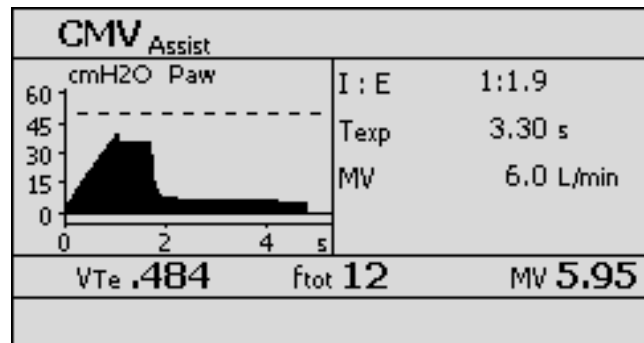
- 1 Frequently used keys for routine functions are positioned on the right-hand side of the front panel:
 - »**Alarm Silence**« key for muting audible alarm for 2 minutes,
 - »**Alarm Reset**« key for resetting or acknowledging alarm messages and for testing the LEDs and audible alarm,
 - »  **lock**« key for protecting against inadvertent or unauthorized modification of ventilator settings.
- 2 Keys for auxiliary functions are positioned on the left-hand side of the front panel:
 - »  **Nebul.**« key for switching integrated nebulizer on / off,
 - »**O₂ ↑ suction**« key for pre-/post- oxygenation when performing bronchial suction,
 - »**Insp. hold**« key for manually activated inspirations and for manually extending inspiratory time.



On Screen Information Window

During setting of a ventilation parameter, Savina re-calculates derivative parameters (marked with an asterisk) and displays them in the information window on the main screen page.

The information window disappears when the parameter setting is confirmed.

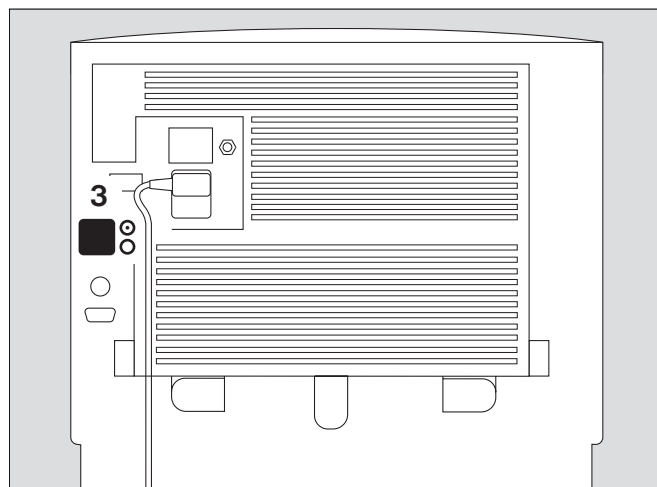


Power Switch

- 3 To switch the ventilator on / off.
Located on the back of the ventilator.

To switch on:

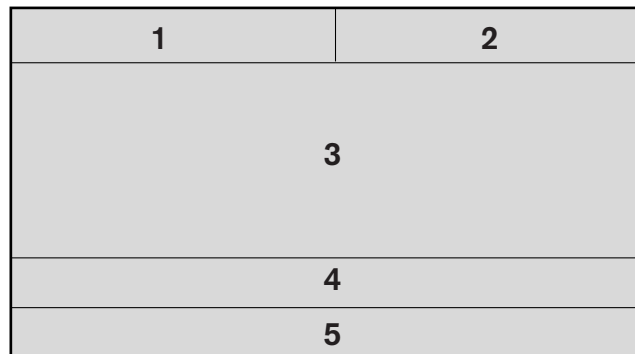
Turn power switch to »  « = ON.



Screen Pages

Structure of the screen pages

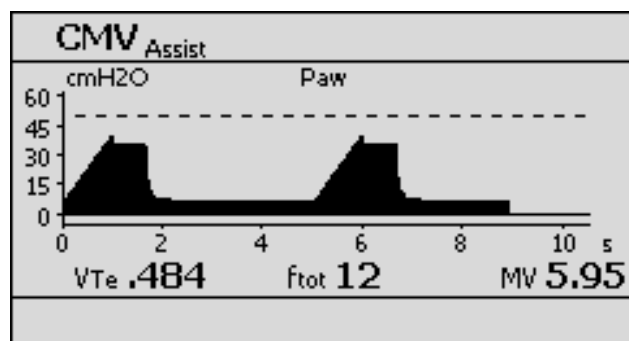
- 1 Ventilation mode display field
- 2 Alarm message display field
- 3 Waveforms and measured values display field
- 4 Measured values display field
- 5 Information bar



107 28 170

Main page

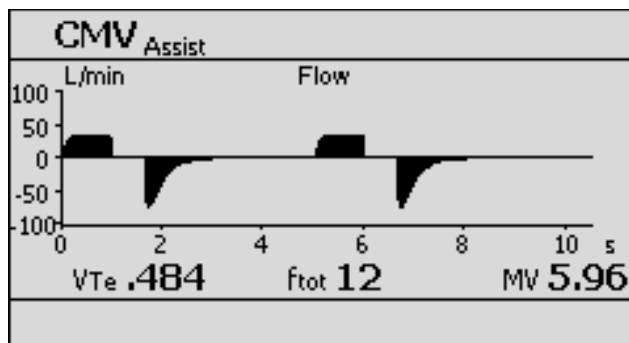
Displays a pressure curve as well as three measured values.
To configure the combination of measured values to be displayed, see page 79.



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Flow waveforms main page

Displays a flow waveform as well as three measured values.
To configure the combination of measured values to be displayed, see page 79.



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Operating Concept

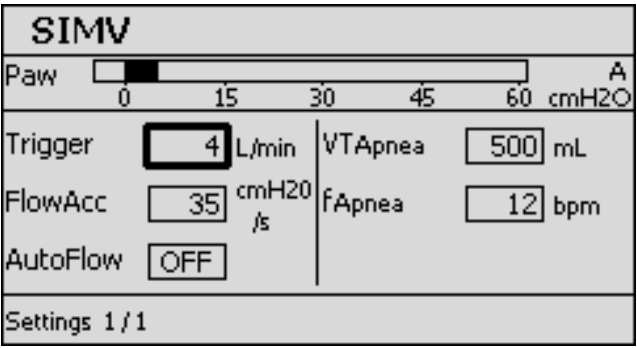
"Settings" screen page
"Alarms" Screen Page
"Values" Screen Page

"Settings" screen page

- Analog bar display of the airway pressure Paw.
- Setting menu for setting the supplementary ventilation parameters »Trigger«, »FlowAcc«, »AutoFlow«,
- Setting menu for setting apnea ventilation, with the parameters »VTApnea«, »fApnea«,
- Setting menu for setting the sigh in the form of an intermittent PEEP.

Settings 1/1:
Menu comprises a single page.

- To select parameters, turn dial knob.
The selected parameter is indicated by a bold frame.
- To activate parameter for setting, press dial knob.
The active parameter appears now light on a dark background.
- To set parameter, turn dial knob.
To confirm, press dial knob.

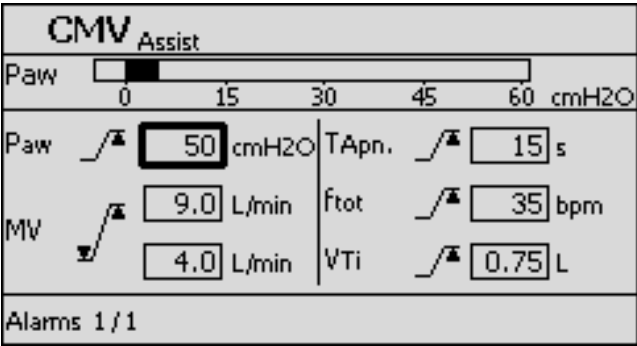


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"Alarms" screen page

- For displaying alarm limits associated with measured values.
- For setting alarm limits.

For detailed operating instructions, see "Setting alarm limits" on page 64.

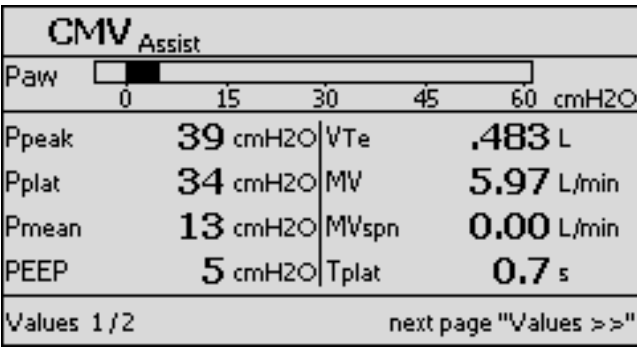


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"Values" screen page

- For displaying all measured values of the current ventilation mode.

Values 1/2:
Page 1 of 2 available pages.

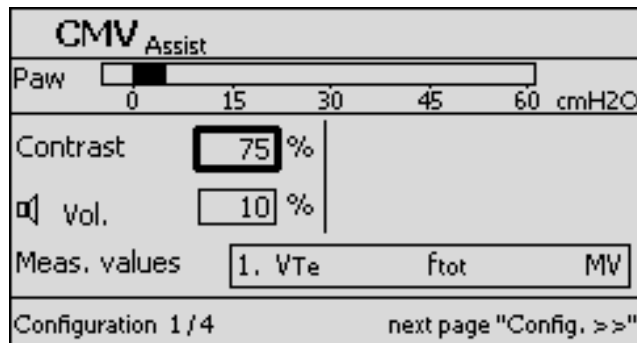


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"Configuration" screen page

For setting equipment parameters:

- Screen contrast
- Alarm volume
- Measured values displayed
- Manual calibration for O₂ sensor 2
- FiO₂ and Flow Monitoring ON / OFF
- Pmax ON / OFF
- Plateau ON / OFF
- Language, date, and time
- MEDIBUS protocol



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- Configuration 1/4:

Page 1 of 4 available pages of the Configuration menu.

Changing screen pages

To change to the next page:

- press the same key again.

To change to another page:

- press the respective key for that page.

To change to the main page for pressure waveforms:

- press »Waveforms  « key.

For detailed instructions for use, see "Configuration", beginning on page 78.

»Standby« Key

- 1 Positioned at bottom right of the front panel.

- To keep the ventilator ready for operation,
- e.g. after pre-setting.

or

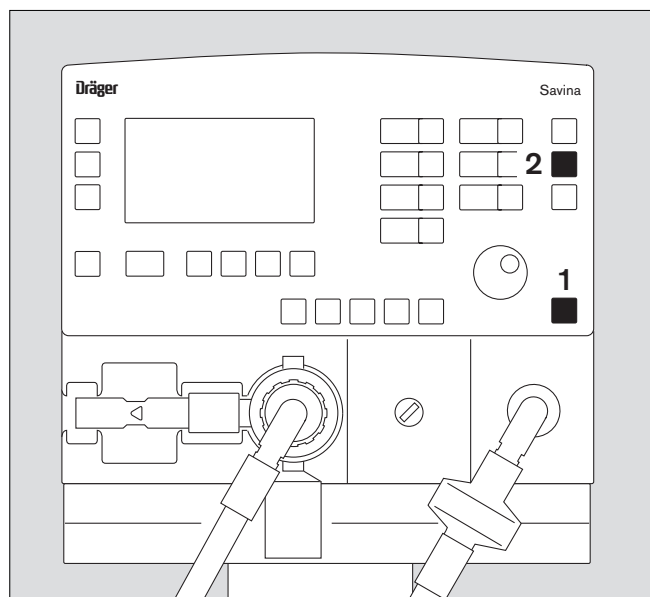
- to switch on ventilation.

To switch to standby:

- 1 Hold down »Stand by« key for at least 3 seconds and
- 2 press »Alarm Reset« key to confirm.

To switch on ventilation:

- 1 Press »Stand by« key briefly.



004 37261

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Preparation

Assembly of Components	30
Assembling the expiratory valve	30
Installing the expiratory valve	30
Installing the flow sensor	31
Installing a bacteria filter	31
Precautions When Using Expiratory Bacteria Filters	32
Precautions When Using Heat/Moisture Exchangers	33
Installing a Heated Humidifier	34
Supplies and Connections	36
Connecting the O2 Supply	42
Before Using Ventilator on a New Patient	42
Nurse Call System (Available Option)	43
Checking Readiness for Operation	44
Checklist	47

Preparation

Assembly of Components

Assembling the expiratory valve

Installing the expiratory valve

Preparation

WARNING!

Do not place containers of liquids (such as infusion bottles) on top of or above the Savina ventilator. Liquids getting into the ventilator can cause equipment malfunction with the risk of patient injury.

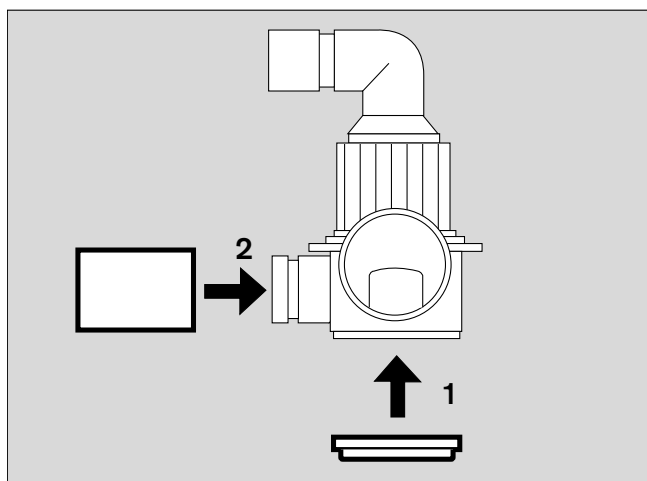
Assembly of Components

WARNING!

Always use components that have been properly cleaned and disinfected

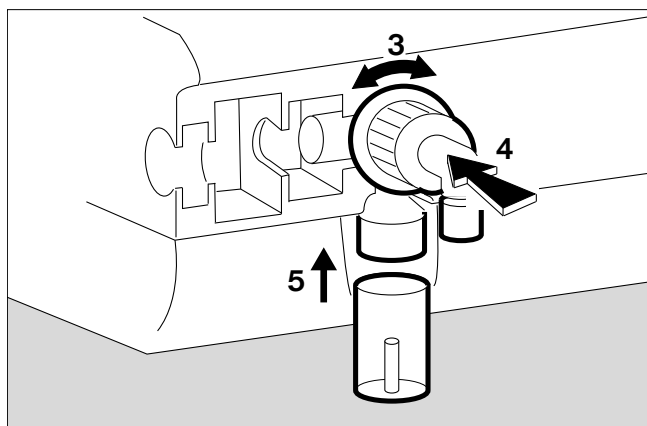
Assembling the expiratory valve

- 1 Install membrane on expiratory valve body
- 2 Push rubber grommet onto expiratory valve port



Installing the expiratory valve

- 3 Turn knurled knob counterclockwise to stop.
- 4 Insert expiratory valve.
- 3 Hand-tighten knurled knob clockwise.
- 5 Install jar of water trap.



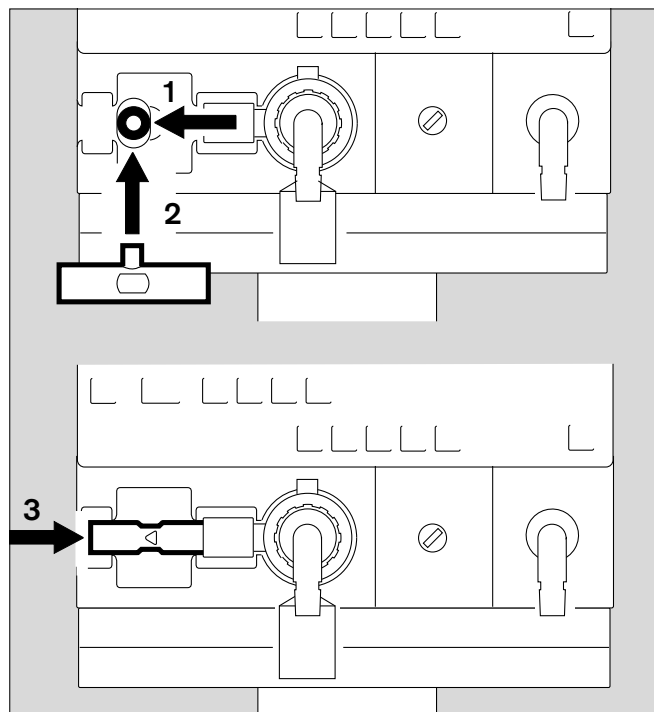
Installing the flow sensor

- 1 Slide flow sensor receptacle all the way to the left

- 2 Insert flow sensor into its receptacle (plug facing the ventilator) and push into its socket as far as it will go.

Then:

- 3 Slide flow sensor fully to the right into the rubber grommet of the expiratory valve.



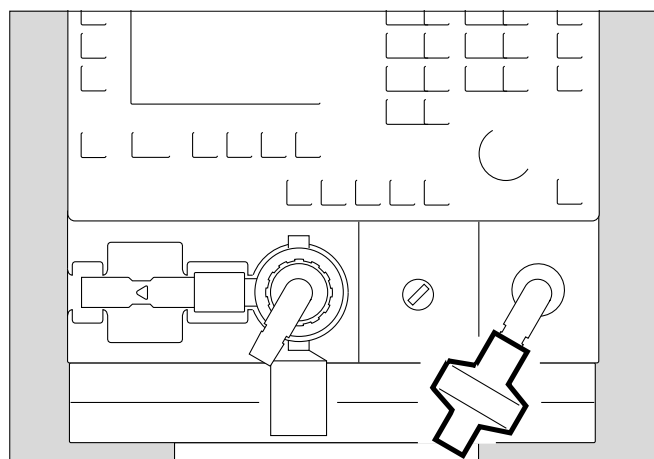
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Installing a bacteria filter

- Install bacteria filter onto the inspiratory port of the ventilator.

WARNING!

Always use bacteria filter on the inspiratory port of the ventilator.



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Precautions When Using Expiratory Bacteria Filters

Expiratory bacteria filters may be used.

Use of bacteria filters in the expiratory side of the patient circuit can cause an undesirable increase in breathing resistance.

Particularly when nebulizing aerosols or humidifying the breathing gas, resistance caused by a bacteria filter may slowly increase, leading to increased work of breathing and to intrinsic PEEP.

WARNING!

The flow resistance of bacteria filters placed in the expiratory side may be substantially increased by nebulized aerosols with the risk of impaired ventilation. If an expiratory filter is used during nebulization, airway pressures and flow should be monitored for any indication of increased expiratory resistance due to filter obstruction.

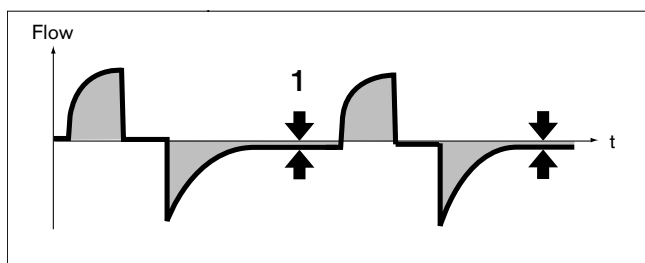
- 1 Increased breathing resistance due to a clogged bacteria filter may be recognized by the fact that expiratory flow has not returned to "0" at the end of expiration.

In this case, airway pressure at the end of expiration will still be above the set PEEP.

If airway pressure is more than 8 cmH₂O above the setpoint for PEEP, the ventilator will generate the alarm message:

!!! PEEP high

- Check bacteria filter and exchange if it proves to be the cause of the high PEEP alarm.



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Precautions When Using Heat/Moisture Exchangers

The use of a heat/moisture exchanger (HME, artificial nose) in the patient connection can increase breathing resistance considerably.

An increase in breathing resistance will lead to increased work of spontaneous breathing and/or greater trigger effort during assisted ventilation. Under unfavorable conditions, an increase in breathing resistance can also lead to intrinsic (inadvertent) PEEP.

The ventilator cannot directly monitor this breathing resistance in the patient connector.

Therefore:

- Check patient condition and the ventilator's measured values for volume more frequently.
- Carefully observe instructions for use of the heat/moisture exchanger (HME)!

WARNING!

Draeger cannot warrant or endorse the safe performance of heat/moisture exchangers with the Savina ventilator.

The user has to verify that the heat/moisture exchanger is covered by a technical safety certificate which guarantees its complete suitability for its intended use.

Do not use a heat/moisture exchanger simultaneously with a nebulizer or heated humidifier!

Risk of increased breathing resistance due to condensation.

WARNING!

Draeger cannot warrant or endorse the safe performance of third party humidifiers for use with the Savina ventilator. Specifically, the user has to assess the risks of delivery of breathing gas not maintained at a proper temperature associated with different humidifier designs. It is strongly recommended to use the electronic temperature monitoring feature of the ventilator if no proximal airway temperature monitoring is performed by the humidifier used.

Increased pneumatic resistance in the inspiratory line caused by a humidifier may result in less accurate airway pressure readings.

We recommend contacting the manufacturers/ distributors of third party humidifier devices about compliance of their products with the requested performance characteristics.

- Prepare humidifier following its Operating Instructions.
- 1 Attach humidifier to mount below ventilator with rail clamp and secure clamp mechanism (screws, lever).

WARNING!

Do not use a heat/moisture exchanger (HME) simultaneously with a heated humidifier!
Risk of increased breathing resistance due to condensation.

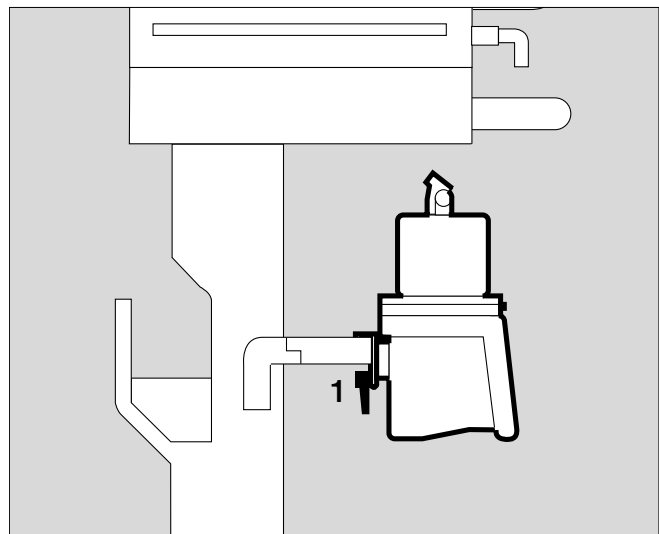
Placement of the humidifier

The hinged circuit support arm can be mounted to either side of the ventilator, depending on the desired position of the ventilator in relation to the patient bed.

For a ventilator placed **to the right** of the patient bed

- Turn both ventilator ports to the left.
- Swivel humidifier to the left

NOTE: In subsequent descriptions, the ventilator circuit system is depicted as being mounted **to the left**.



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For pediatric ventilation

- Always use a humidifier suitable for ventilating small patients
- Always use appropriately sized patient circuits.

Connecting the patient circuit.**WARNING!**

In order to avoid any risk of electric shock in the event of faulty grounding of patient monitoring equipment, do not use antistatic or electrically conductive patient circuits*

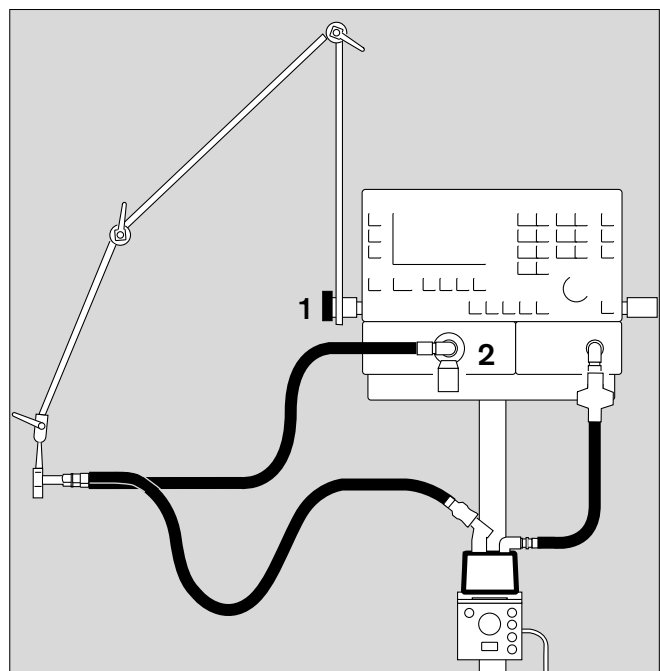
- 1 Attach circuit support arm to the rail on the left-hand side of the ventilator and tighten screws.
- Connect ventilator circuit segments of appropriate lengths.
- 2 Turn ventilator ports in the direction of the circuit.
- Connect wye.
 - Clip wye into its bracket at the end of the circuit support arm.

WARNING!

Do not use inspiratory circuits with a total length of less than 1.1 m (3.6 feet) between humidifier and wye. Otherwise risk of excessive breathing gas temperatures!

WARNING !

Do not use humidifiers without temperature regulation. Otherwise risk of excessive breathing gas temperature!



* NOTE: IEC 601-2-12 "Lung Ventilators" does not consider the use of antistatic or electrically conductive materials for patient circuits of a lung ventilator a contribution to increased safety. To the contrary, the use of such materials increases the risk of electric shock for the patient and the fire risk associated with oxygen

Supplies and Connections

Electrical Power Supply

Connect to line voltage of: 100 V to 240 V AC, 50/60 Hz

Savina is equipped with an auto-switching power supply that adapts to the local line voltage.

- Insert plug into the power outlet.

WARNING !

This device is to be used only in rooms with line power installations complying with national safety standards for hospital patient rooms. (e.g., IEC 601.1, "Safety of Medical Equipment).

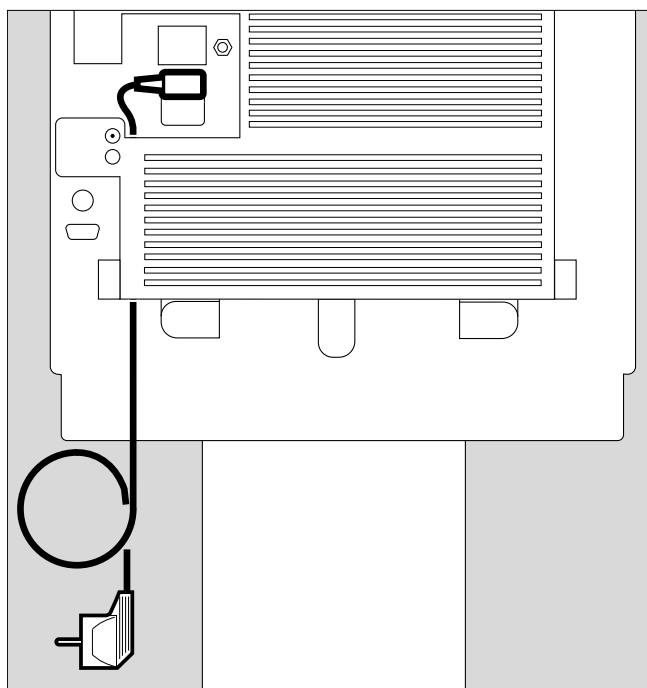
To maintain grounding integrity, connect only to a "hospital grade" receptacle. Always disconnect supply before servicing.

Precautions when using a power strip for auxiliary equipment (available option)

WARNING !

Connecting other devices to the same extension power strip may, in the event of grounding failure, cause the leakage current to the patient to increase beyond the permissible values.

In this case, the risk of electric shock cannot be safely excluded.



Connecting to DC power or external battery

Please refer to "Technical Data", page 124 for external battery specifications)

WARNING !

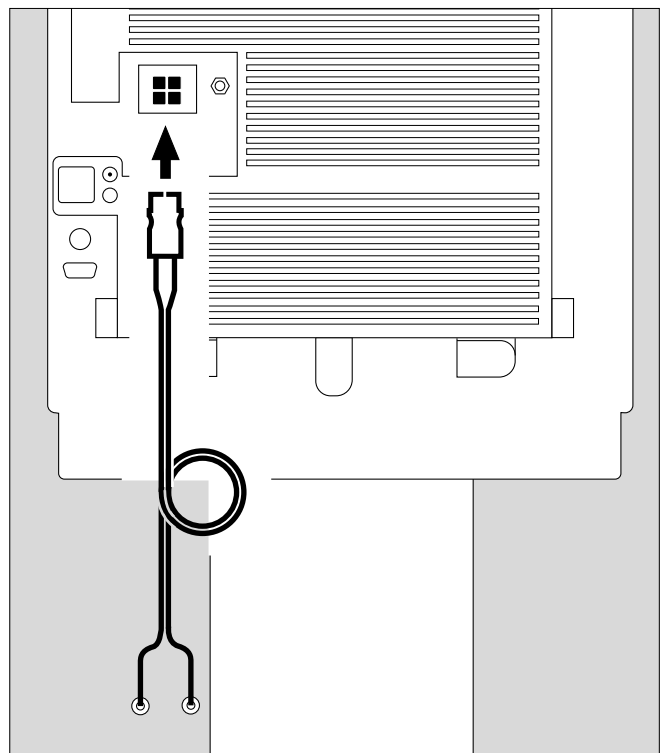
Use rechargeable batteries ONLY.

Because of the charging feature of the Savina DC power supply, connecting non-rechargeable batteries might lead to a risk of explosion when operating the ventilator from line power.

- Connect to external battery with DC on-board network cable, part no. S84 14 048, or with the DC battery cable, part no. S84 14 092.

NOTE: The ventilator-side connector of these cables is coded. Savina uses the coding to recognize whether it is connected to an external battery or an on-board DC supply

- Verify correct polarity
black = –
red = +
Savina ignores an incorrectly connected battery or on-board DC supply.
- Insert connector into the DC input receptacle in the back of the ventilator



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CAUTION !




Do not connect AC/DC power supplies to the DC input.

Internal battery

In case of a line power failure or a discharged or not connected external battery, Savina will automatically switch to supply power from its internal battery.

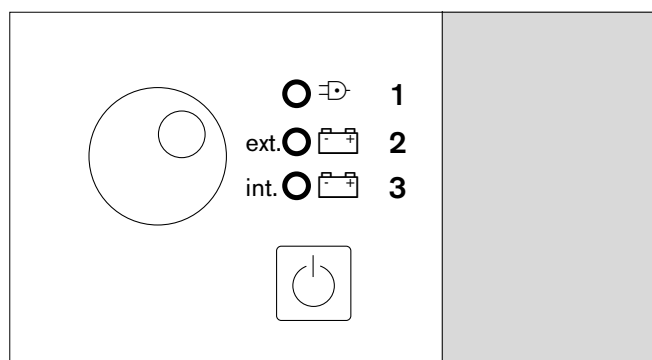
Displaying the active power supply

The power supply status is indicated by three status LEDs to the right of the control knob.

- 1 Line power status light »«
- 2 Status light for on-board DC »ext. «
(e.g. in an ambulance or helicopter) or external battery (e.g. when used with a wheeled transport stretcher).
- 3 Status light for internal battery »int. «.

Color coding for the status lights

- green power source available
- yellow: battery charging
- off: power source not available



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Preparation

Supplies and Connections

Power source priorities

Savina automatically prioritizes the use of the different power sources.

AC line power:

Savina automatically switches to AC line power when available and charges the internal and external batteries.

WARNING !

Leave Savina connected to AC line power only in well ventilated rooms (air circulation: minimal 1.2 m³/h). Charging batteries generates hydrogen that, with sufficient concentration, could cause an explosion with the risk of personal injury.

External battery or on-board DC power:




While connected to a DC power source, Savina will automatically switch to the external battery or on-board DC supply in case of an AC line power failure.

Internal battery:

The internal battery is used when neither AC line power nor a DC power source is available.

Operation from AC line power

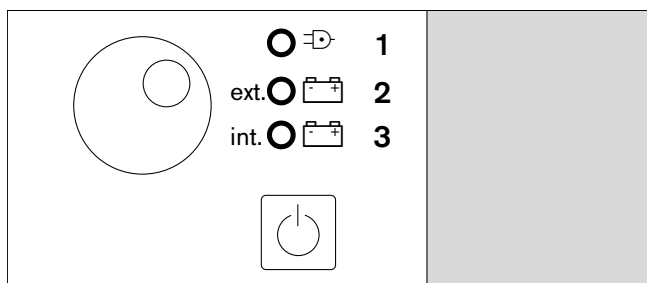
Display (example):

- 1 Savina connected to AC line power:
Status light »« is lit green.
- 2 External battery not fully charged:
Middle status light »ext. « is lit yellow
- 3 Internal battery fully charged:
lower status light »int. « is lit green

When operating the ventilator on AC line power, the internal battery is charged first. Only when this battery is fully charged (status light green), an external battery will be charged next.

Savina automatically detects the voltage of the external battery (12V or 24 V).

Once the respective battery is fully charged, continued trickle charging will compensate for self-discharge of the batteries.



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
Operation from an external battery or an on-board DC power source

In case of AC line power failure, Savina will switch, without interruption, to an available DC source.

The supply may be one of two different types:


- supply via an external rechargeable battery
or
- supply via an on-board DC supply

Savina will recognize whether an external battery or an on-board DC power system is connected. This avoids Savina attempting to charge an on-board system.


- 1 When operating from an external battery or on-board DC system, the status light »ext. « is lit green.

Display (example):


No AC line power:

upper status light »« off

Supply from an external battery:

middle status light »ext. « is lit green

internal battery fully charged:

lower status light »int. .« is lit green.

In case of a discharged external battery or failure of the on-board DC system, Savina switches to the internal battery with the caution message

!! Int. battery activated

Acknowledge message by pressing »Alarm Reset« key

A notice remains on screen

! Int. battery activated

The time of operation from an external battery depends on the type and charge of the battery connected.

7 hours of operation can be expected for a fully charged

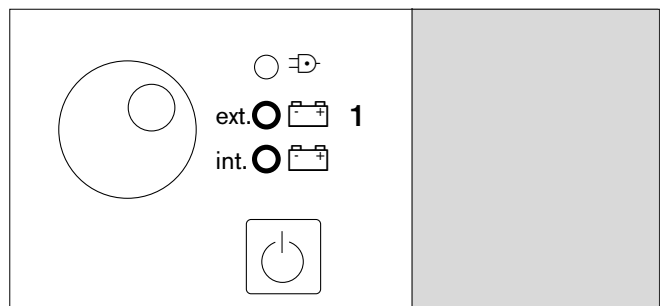
24 V/17 Ah battery.

Savina recognizes when the external battery has been discharged and switches to the internal battery.

After the return of AC line power, Savina will first recharge the internal battery and subsequently the external battery.

NOTE: The internal battery is not charged beyond the level of a trickle charge when ventilator power is supplied by an external battery.

- Immediately supply the ventilator again with AC line power so that the internal and external batteries may be fully recharged again



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


Preparation

Supplies and Connections

Operation from the internal battery

If the ventilator is not connected to an external DC source or the external battery is discharged, Savina will switch, without interruption, to its internal battery in case of AC line power failure.

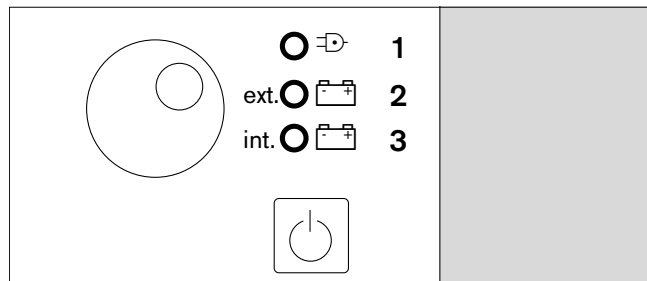
Display:

- 1 No AC line power:
upper status light »« off
- 2 No supply from an external battery or on-board DC source:
middle status light »ext. « off
- 3 internal battery fully charged:
lower status light »int. « is lit green.

When switching automatically to the internal battery, the following caution message is displayed

!! Int. battery activated

- Press »Alarm Reset« key to acknowledge message.
The message changes to an advisory:
! Int. battery activated



067 37261

Operating time for the internal battery depends on its level of charge.

With a new, fully charged battery and a typical ventilation, operation is possible for approximately 60 minutes.

After operating for about 20 minutes, the ventilator displays a caution message:

!! Int. battery low

- Immediately re-establish AC power.
or
- connect ventilator to a charged external battery or to an on-board DC system.

At the end of the time of operation with internal battery, the ventilator displays a warning message:

!!! Int. batt. almost discharged

- In order to avoid an interruption of ventilation re-establish power from an external source immediately, either from AC, a charged external battery, or from an on-board DC system.

After using Savina with power from its internal battery:

- Supply AC power in order to recharge the internal battery (and the external battery where applicable) right away.

NOTE: The internal battery is not charged beyond the level of a trickle charge when ventilator power is supplied by an external battery.

NOTE: The internal battery is charged when the ventilator is connected to an on-board DC system.
The charging time is approximately 5 hours.

- Always ensure that the internal battery is charged from an AC or on-board DC supply.

NOTE: The internal battery supplies power to the two O₂ sensors even when ventilator power is switched off. Savina is then able to provide valid O₂ measurements right after switching the ventilator on.

NOTE: If the battery had been discharged completely, Savina will not display O₂ measurements for the first 20 minutes after switching on the ventilator. The O₂ blender works with reduced accuracy during this time.

Preparation

Connecting the O₂ Supply

Before Using Ventilator on a New Patient

Connecting the O₂ Supply

WARNING !

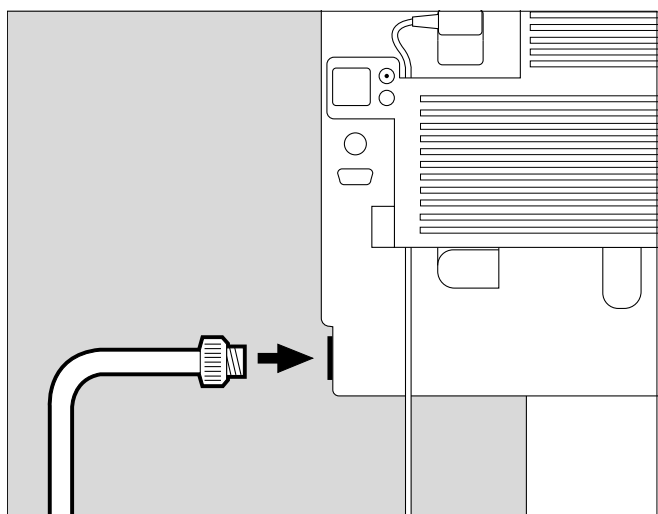
Always use medical grade oxygen that is dry and free from contaminations. Contaminated gas may cause ventilator malfunction.

Supply pressure must be between 39 and 87 psi (2.7 to 6 bar)

- Screw high pressure oxygen hoses to socket on the side of the ventilator and supply oxygen from a wall terminal or O₂ cylinder.

NOTE: An optional screw-on elbow adapter is available for making the O₂ connection to the ventilator.

NOTE: Due to the blending of gases, a set O₂ concentration will be reached after 3 minutes from the time of setting. The blending might take somewhat longer, however, when minute volumes less than 2 L/min are delivered. In this case, the alarm "High O₂" or "Low O₂", respectively, will indicate that the set concentration has not been reached within the allotted time.



Before Using Ventilator on a New Patient

- Check readiness for operation (page 44)

WARNING !

The ventilator is ready for operation only when:

- it is completely assembled with all required auxiliary equipment in place,
- all sensors are calibrated (O₂, Flow)
- all tests of readiness for operation have been completed successfully.


Nurse Call System (Available Option)

Connection on the rear panel of Savina intended for the transmission of alarm signals to a central hospital alarm system.

WARNING !

- Installation of the Savina nurse call kit should only be performed by DraegerService or factory trained and authorized service personnel.
- Have a qualified electrician perform the installation of the round 6-way DIN female connector to the line of the central alarm system.

Savina activates the nurse call by closing contacts 3-5 whenever a WARNING level alarm (three exclamation marks !!!) is displayed.

- Insert plug into the »  « socket on the back panel of the ventilator and screw in tightly.

WARNING !

The operator of the ventilator must still assume full responsibility for ventilation monitoring via the Savina screen when the nurse call is connected.
Only warning messages (!!!), i. e. alarm messages with top priority, will activate the nurse call.

- Regularly check on-screen messages.

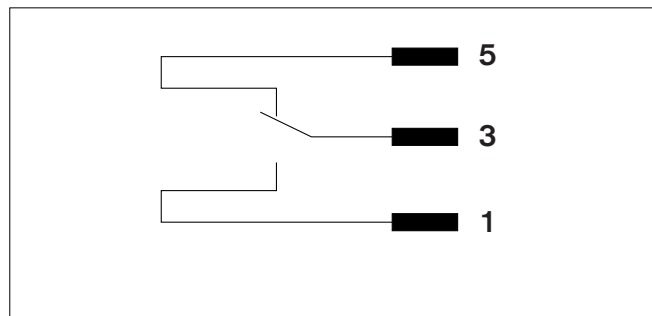
Warning messages that are transmitted via nurse call appear with 3 exclamation marks in the upper line on screen, see page 66. Caution and advisory messages will **not** be transmitted. The nurse call system will also be activated when the original enunciator in the ventilator is faulty.

- Test nurse call system for proper functioning after it has been connected.

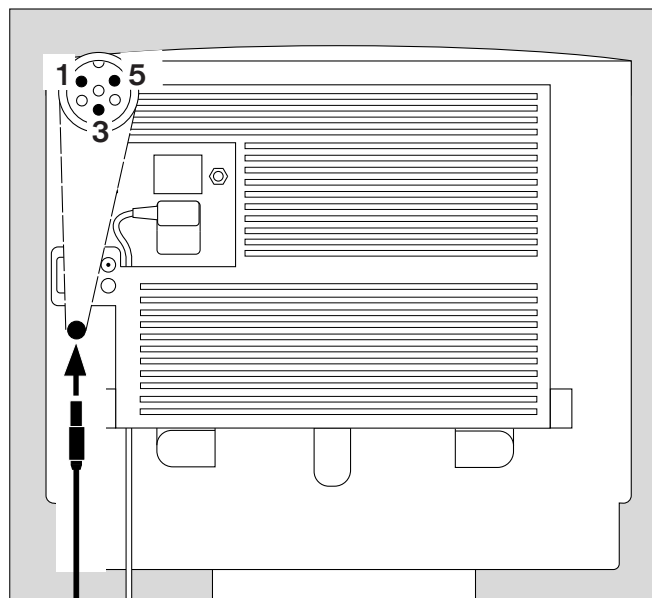
WARNING !

A fault within any component of the combination between the nurse call and the central alarm system of the hospital (e. g. inside the Savina nurse call electronics, the Savina power supply or the hospital alarm equipment) may result in a failure of a proper nurse call function.

Background: the connected lines of the central alarm system only are a one-channel design. Therefore, the internal electronics of the Savina nurse call are a one-channel design as well.



023 37261



023 37261

Preparation

Checking Readiness for Operation

Technical data

Potential-free DC contact

Input voltage max. 40 V DC

Input current max. 500 mA

Switching power max. 15 W

Checking Readiness for Operation

Perform immediately before using the ventilator on a patient:

The following functional tests are performed:

(Please refer also to the Checklist on page 47).


- Function of status lights, displays, and audible alarm
- Ventilation function
- Function of PEEP valve
- Measurement of expiratory minute ventilation
- Measurement of inspiratory O₂ concentration FiO₂
- Lower alarm limit for minute ventilation
- Lower alarm limit for P_{aw}
- Power failure alarm
- O₂ alarm

Connecting a test lung to the wye.

The test lung consists of an elbow mask adapter for connection to the wye, a 7 mm catheter adapter for simulating airway resistance, and a 2 L breathing bag (part no. 84 03 201 for simulating lung compliance

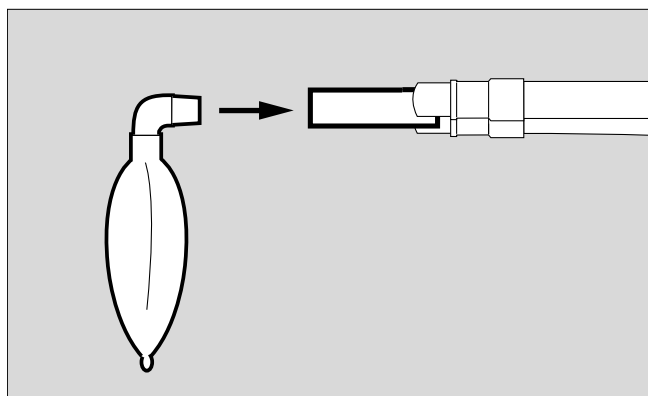
- Connect elbow mask adapter to the patient wye.

Switching ventilator on

- Set power switch on the back panel of the ventilator to »  « position

Savina now performs a power-on self test

- Wait for the 12 second test to complete.



Savina automatically adapts its blower speed to the gas requirements of the patient. When starting a ventilation or adjusting ventilation parameters, a slight whine may be heard temporarily. This is normal.

Checking LEDs and audible alarm

After completing the 12 second test phase, the ventilator lights all LEDs, all lights in the keys, as well as status lights for trigger and power. The audible alarm is briefly activated.

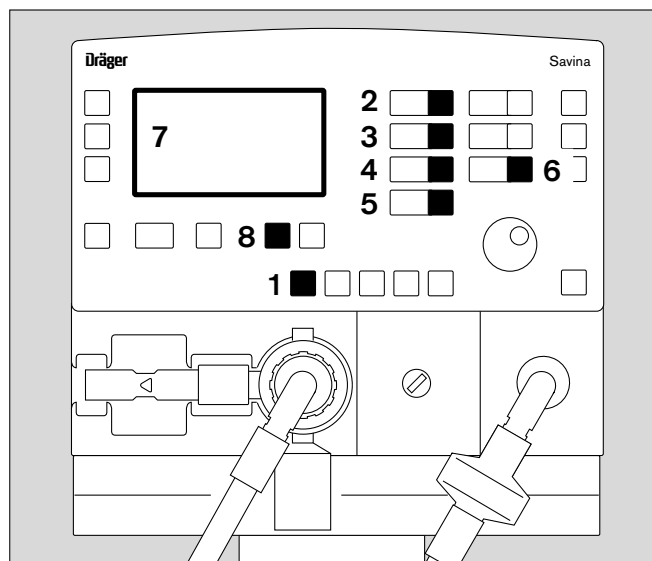
The status light indicating the current power source is continuously lit.

Checking ventilatory function

- 1 Ventilation mode CMV
- 2 »Vt« 800 mL
- 3 »Tinsp« 2 s
- 4 »Rate« 10 bpm
- 5 »O₂« 60 Vol. %
- 6 »PEEP« 5 cmH₂O
- 7 »Trigger« 5 L/min set on screen page »Settings 1/1«

Savina now ventilates the test lung with the set ventilation pattern.

- 8 Select »Values 1/2« with »Values ▸▸« key.
- The bar graph in the screen shows airway pressure fluctuating between inspiratory and end-expiratory pressure in the rhythm of inspiration and expiration.



Display PEEP:

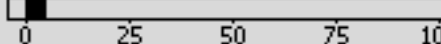
PEEP 5 cmH₂O

tolerance ± 2 cmH₂O

Display minute ventilation:

MV 7.8 L/min

tolerance ± 1.0 L/min

CMV Assist			
Paw			
Ppeak	51 cmH ₂ O	VTe	.632 L
Pplat	40 cmH ₂ O	MV	7.78 L/min
Pmean	16 cmH ₂ O	MVspn	0.00 L/min
PEEP	5 cmH ₂ O	Tplat	1.0 s
Values 1/2		next page "Values >>"	

- 8 Press »Values ▸▸« key to select »Values 2/2«

Display O₂ concentration:

FiO₂ 60 %

tolerance ± 3 Vol. %

- Detach test lung from wye.

Display after approximately 45 seconds

MV 0 L/min

+ 0.5 L/min tolerance

An alarm message will appear on screen:

!!! Airway pressure low

- Reconnect test lung to wye.

Preparation

Checking Readiness for Operation

Power failure test

- Pull AC or DC plug from external power source.
The ventilator should switch to its internal battery and continue ventilation.

Display

!! Int. battery activated

- Plug unit back into AC or DC.

Testing the O₂ alarm

- Pull quick connect of O₂ supply hose from gas outlet:
Intermittent audible alarm and display message:

!!! O₂ supply down

Savina will ventilate with Air only.

- Reconnect quick connect to the O₂ source.

A warning message

!!! FiO₂ low

may appear briefly.

- Press »Alarm Reset« key.

If all tests of readiness for operation have been completed successfully, the ventilator is now ready for operation.

Checklist

Perform checks before each use.

Ventilator is completely assembled and ready for operation,
test lung is connected

What	How	Target
Function of lights/LEDs and audible alarm	Switch ventilator on:	All lights and LED digits light up, the audible alarm starts sounding.
Function of power failure audible alarm	Keep » Alarm Reset « key pressed for approximately 3 seconds:	Audible alarm starts.
Apnea alarm	Switch to CPAP ventilation mode set PEEP to 10 cmH ₂ O, Simulate spontaneous breathing by cycling the test lung (pressing and releasing), then stop this simulation: Press » Alarm Reset «. key.	Upon expiration of the apnea alarm delay T_{apnea} : Audible alarm starts, warning message appears on screen: !!! Apnea
"PEEP high" alarm Emergency venting valve	Switch to CMV ventilation mode, Set Paw \nearrow to 100 cmH ₂ O, Block flow sensor. Press » Alarm Reset «. key.	Audible alarm starts, red alarm light blinking, warning message appears on screen: !!! PEEP high pressure drops down to 0 cmH ₂ O
"Airway pressure high" alarm	Set Paw \nearrow below current maximum airway pressure: Set Paw \nearrow to 100 cmH ₂ O, Press » Alarm Reset «. key.	Audible alarm starts, warning message appears on screen: !!! Airway pressure high
"MV low" alarm	Set MV \downarrow above currently measured value of MV: Set MV \downarrow back to a value below currently measured value of MV: Press » Alarm Reset «. key.	Audible alarm starts, red alarm light blinking, warning message appears on screen: !!! MV low
Test for leaks in patient circuit	Set low ventilator Rate , long inspiratory time T_{insp} , and high flow acceleration FlowAcc . Observe pressure waveform.	Plateau pressure remains constant.

WARNING !

Do not use ventilator if the tests are not completed successfully.

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Operation

Precautions During Operation	50
Starting Up	51
Setting Ventilation Modes	52
CMV, CMV _{Assist}	54
SIMV, SIMV / PS	58
PCV+ (BIPAP), PCV+ / PS (BIPAP/PS)	60
CPAP, CPAP / PS	61
Apnea Ventilation	62
Setting Alarm Limits	64
Operation at High Ambient Temperature	65
In the Event of an Alarm	65
Alarm Categories	66
Silencing Audible Alarms	67
In the Event of a Gas Supply Failure	68
Displaying Waveforms and Measured Values	69
Displaying Measured Values	69
Special Functions	70
Nebulizing Medicated Aerosols	71
Pre-/Post-Oxygenation for Bronchial Suction	73
Calibrations	75
Calibrating O ₂ Sensors	76

Operation

Precautions During Operation

WARNING !

Always use ventilator that has been cleaned and disinfected and has been successfully tested to be ready for operation.

WARNING !

In case of a fault in any of the built-in monitoring a substitute has to be provided in order to maintain an adequate level of monitoring. The operator of the ventilator must still assume full responsibility for proper ventilation and patient safety in all situations.

WARNING !

If a fault is detected in the ventilator and its life-support functions are in doubt, ventilation must be started without delay with an independent ventilation device (resuscitation bag) - using PEEP and/or increased inspiratory O₂ concentration where necessary and appropriate. The unit should then be removed from use and serviced by an authorized service technician.

WARNING !

- Always use extreme caution when using oxygen!
- Oxygen intensely supports any burning!
No smoking, no open fire in areas where oxygen is in use!
- Always provide adequate ventilation in order to maintain ambient O₂ concentrations < 24 %.
- Always secure O₂ cylinders against tipping, do not expose to extreme heat.
- Do not use oil or grease on O₂ equipment such as tank valves or pressure regulators.
Do not touch with oily hands. Risk of fire!
- Open and close valves slowly, with smooth turns.
Do not use any tools.

WARNING !

Always heed all precautions and follow all hospital protocols with respect to the administration of oxygen. Make adjustments to the FiO₂ according to the blood gas values measured.

WARNING !

Do not block air intake. Ventilator malfunction will result.

WARNING!

Do not place containers of liquids (such as infusion bottles) on top of or above the Savina ventilator. Liquids getting into the ventilator can cause equipment malfunction with the risk of patient injury.

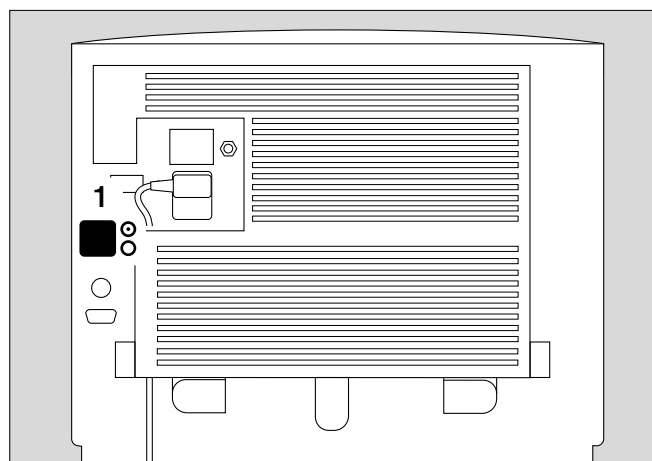
Perform tests of readiness for operation according to checklist, see page 47.

Starting Up

Switching on

- 1 Turn main switch on the back of the ventilator to » ⏻ «.
- Savina now performs a power-up self test procedure.
- Wait for the 12-second test phase to be completed.

At the end of this self test , the ventilator automatically starts ventilation with the last ventilation mode and associated ventilation parameters set.



101_37261

During the self-test, the start-up page appears, showing the software version.



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After the start-up page, the main page appears.

- Check settings in the display fields next to the parameter keys and adjust as necessary.

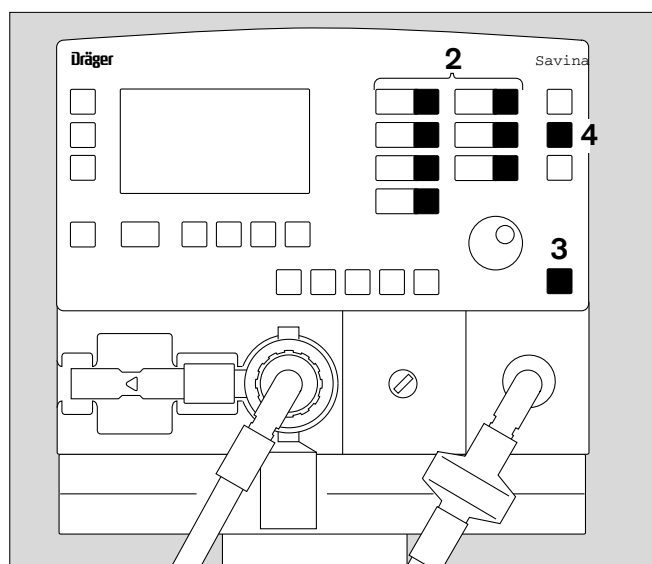
To adjust ventilation parameters:

Either

- 2 Change ventilation parameters after Savina has started ventilation

or

- 3 Press »Stand by« key to set Savina to standby.
- 4 Press »Alarm Reset« key to confirm.
- 2 Change ventilation parameters and
- 3 Press »Stand by« key to return to ventilation.



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Setting Ventilation Modes

Setting ventilation parameters

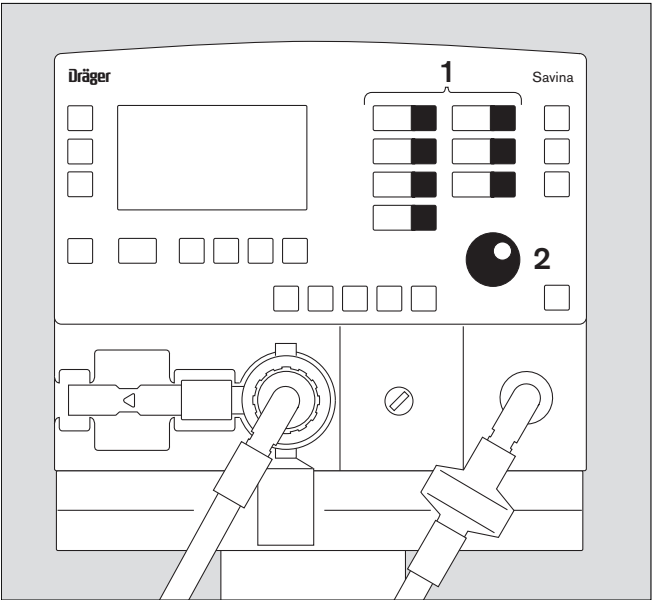
- 1 Press the respective ventilation mode key.
The yellow LED in the key will light up.
- 2 Set desired value by turning the dial knob.
Press dial knob to confirm settings.
The yellow LED in the key will go out.

If a setting exceeds the standard adjustment range, the value in the parameter key display will start flashing, indicating that confirmation is required.

- Press dial knob to confirm values outside the standard range.
- Turn dial knob to set value.
- Press dial knob to confirm.

Parameter settings for the active ventilation mode do not go into effect until confirmed.

If you fail to confirm new settings within 20 seconds, the previous settings simply will remain in effect.



Settings outside the standard range

Certain ventilation parameter settings are initially limited by Savina to not exceed a threshold value. Values exceeding the threshold can only be set after confirmation by pressing the dial knob (see above).

Parameter	Threshold	Range
P _{insp}	↑ 50 cmH ₂ O	0 to 100 cmH ₂ O
P _{max}	↑ 50 cmH ₂ O	0 to 100 cmH ₂ O
PEEP	↑ 20 cmH ₂ O	0 to 35 cmH ₂ O
ΔP _{supp.} (above PEEP)	↑ 20 cmH ₂ O absolute	0 to 35 cmH ₂ O absolute
Δ Sigh	↑ 20 cmH ₂ O absolute	0 to 35 cmH ₂ O absolute
FlowAcc	↓ 20 cmH ₂ O/s	5 to 200 cmH ₂ O/s
Rate, T _{insp} *	↑ I:E > 1:1 ↓ I:E < 1:3	2 to 80 bpm 0.2 to 10 s

* Limitation of f and T_{insp} is determined by I:E ratio

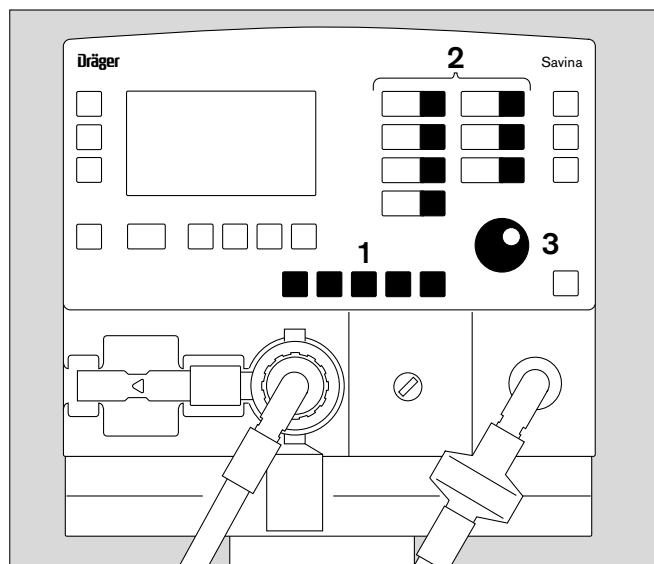
Setting extended range values:

- Turn dial knob to set extended range threshold,
Press dial knob to confirm.
- Turn dial knob for extended range setting,
Press dial knob to confirm set value.

NOTE: Confirmation is not necessary when settings are reduced to fall within the normal range again.

Pre-setting parameters for another ventilation mode

- 1 Press key for the new ventilation mode briefly.
The yellow LED will start blinking.
- 2 In the block of parameter keys, the LEDs for any additional parameters required for the new ventilation mode will start blinking.
- 2 Press the respective parameter key. Its LED will stop blinking and remain constantly lit.
- 3 Turn dial knob to set the desired value.
Press dial knob to confirm value.
The yellow LED will go out.
- 3 Press dial knob to activate ventilation mode




To activate a ventilation mode


- 1 Hold down the key for the ventilation mode for approximately 3 seconds,
- or
- 1 Press the key for the ventilation mode briefly, and
- 3 press dial knob to confirm.

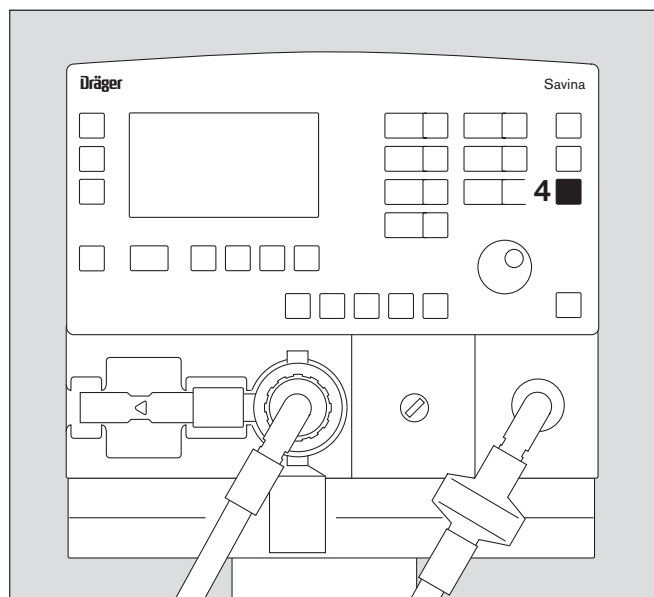
The new ventilation mode selected is now in effect.
Ventilation always starts with the last settings.

To protect settings against modification

- 4 Press »  Lock « key; its yellow LED will light up.
Parameter keys, ventilation mode keys, and the screen settings are now protected against any changes.

Before setting a new value:

- 4 Press »  Lock « key again. Its yellow LED will go out.



CMV, CMVAssist

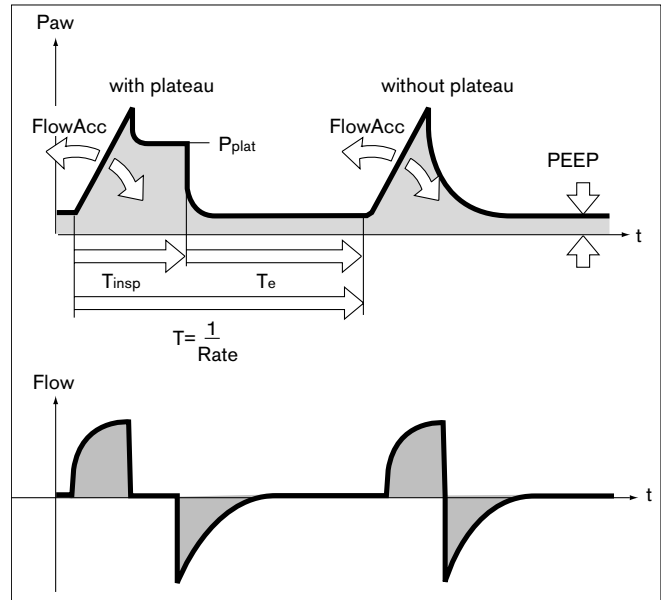
Continuous Mandatory Ventilation

Volume-controlled ventilation with a fixed mandatory minute volume MV, set with the tidal volume VT and ventilator rate. Intended for patients unable to breathe spontaneously, see page 128 for details.

Continuous Mandatory Ventilation, Assist for patients with partial spontaneous breathing.

Set CMV with the ventilation parameter keys:

- Tidal volume »VT«,
 - Inspiratory time »Tinsp«,
 - Ventilator rate (frequency) »Rate«,
 - O2 concentration »O2«,
 - Positive end-expiratory pressure »PEEP«.
- For a PEEP setting above 0, airway pressure will always remain positive (Continuous Positive Pressure Ventilation, CPPV).



CMV may be supplemented with the following ventilation mode extensions and parameters:

Pmax pressure limit

A pressure limit may be set in CMV, CMVAssist in order to avoid pressure peaks.

To set the pressure limit:

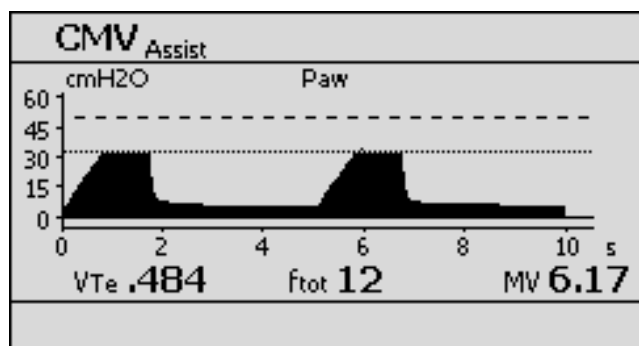
- Switch Pmax ON, see page 82
- Set pressure limit with »Pinsp« key.

When setting the pressure limit, take care that the required tidal volume VT is still delivered. Otherwise Savina will display the message "VT low". If this happens:

- Increase pressure limit
- or
- increase inspiratory time »Tinsp.«
- or
- Increase FlowAcc.

This setting can be made on-screen:

Flow delivery is controlled by the setting of "Flow Acceleration" »FlowAcc« on screen page »Settings 1/1«, see page 55.

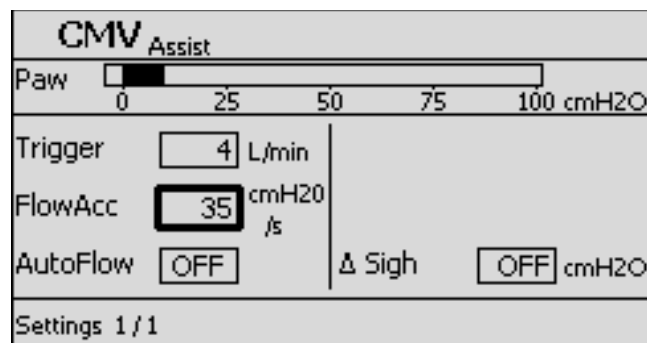


Flow Acceleration FlowAcc

By setting the FlowAcc, the pressure and flow increase at the start of inspiration can be changed.

To set FlowAcc:

- Press »**Settings** $\triangleright \triangleright$ « key, screen page »**Settings 1/1**« appears.
- Turn dial knob to select value for »**FlowAcc**« on screen, press dial knob to confirm.
- Turn dial knob to set value.
Setting range: 5 to 200 cmH₂O/s
FlowAcc high: steep pressure and flow increase
- Press dial knob to confirm setting.
- A recommended startup setting for FlowAcc is 35 cmH₂O/s.



124 37222

CMV can be extended using the following ventilation parameters:

- Trigger
- Sigh
- AutoFlow (optional)

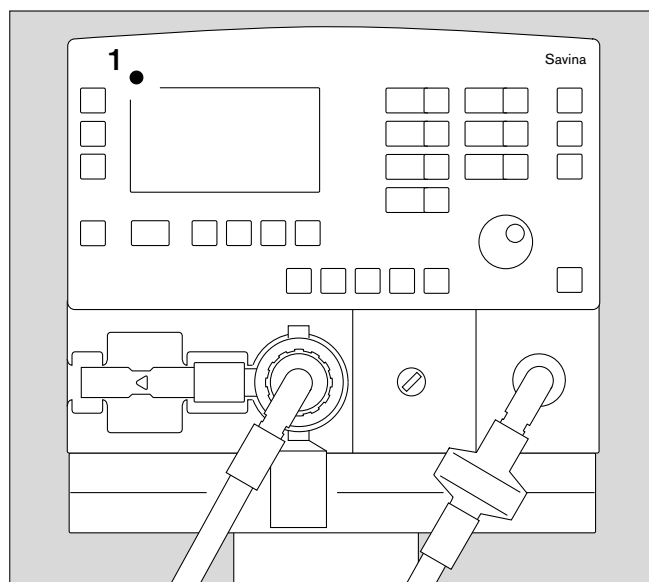
Trigger (CMVAssist)

To start ventilator breaths in synchrony with a patient's spontaneous breathing efforts. The actual breath rate may be higher than the set ventilator rate.

- 1 The green LED will light up whenever Savina has detected a spontaneous breathing effort.

The trigger may be switched off if no spontaneous breathing by the patient is expected or desired.

To set the trigger, see page 56.



108 37261

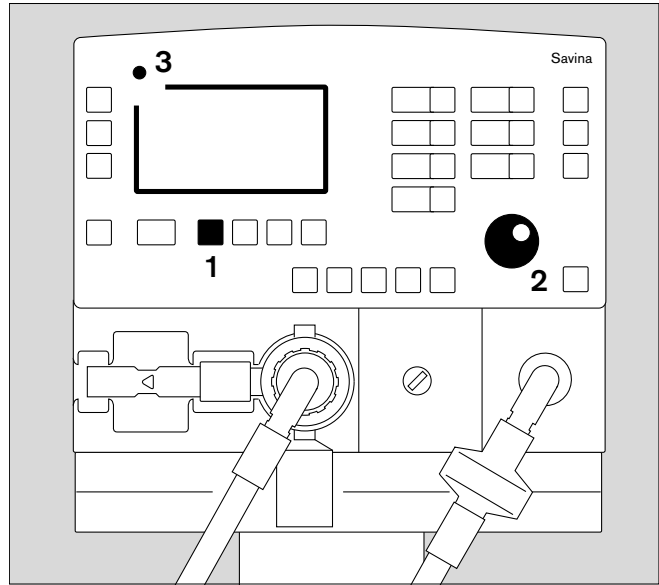
Activating/setting the trigger

- 1 Press »Settings $\triangleright \triangleright$ « key.
- 2 Press dial knob to release »Trigger« for setting.
The value is now highlighted (light on a dark background).
- 2 Turn dial knob to set value.
Low value = high sensitivity
Press dial knob to confirm.

On screen, the ventilation mode **CMVAssist** is now displayed.

- 3 The green LED will light up whenever Savina has detected a spontaneous breathing effort.

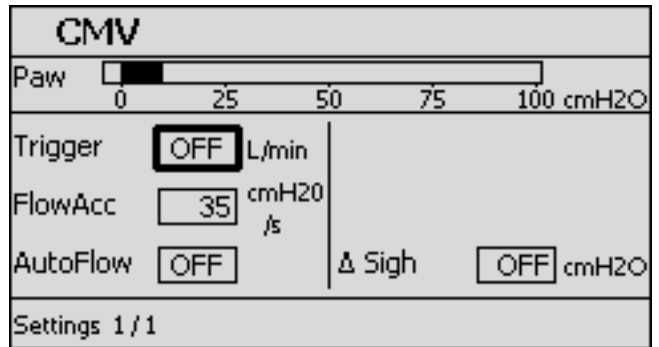
NOTE: When switching from CMV (no assist) to SIMV, PCV+ or CPAP/PS, the last trigger sensitivity setting used will be in effect.



To switch trigger off:

- Set a value less than 1. Display in the trigger field: OFF
- 2 Press dial knob to confirm.

On the screen, CMV is now showing as the ventilation mode.



Sigh

used to prevent atelectasis.

As a preventive measure against atelectasis sigh breaths may be set in the form of an intermittent PEEP.

Activating the sigh function will increase the end-expiratory pressure by the set intermittent PEEP for 2 ventilator breaths every 3 minutes.

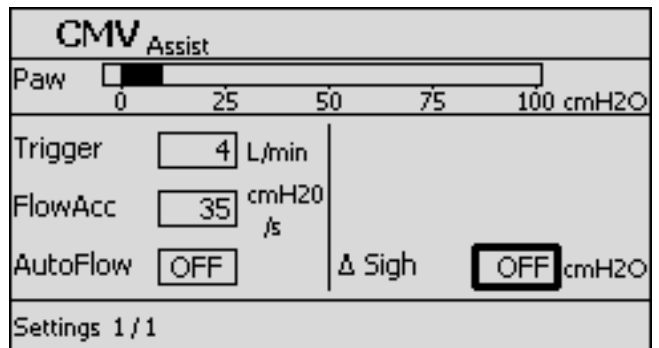
Activating/configuring sigh breaths

- Press »Settings $\triangleright \triangleright$ « key.
- Turn dial knob to select the item »Δ Sigh« on screen.
- Press dial knob to release »Δ Sigh« for setting.
The field appears bright against a dark background.
- Turn dial knob to set a value between 1 and 35 cmH2O.
Press dial knob to confirm.

This value of sigh pressure is added to the set PEEP.

Deactivating the sigh

- Set a value less than 1. OFF appears in the display.
The sigh function is deactivated.



AutoFlow® (optional)

Automatic optimization of the inspiratory flow.

With AutoFlow^{*}, inspiratory flow is decelerated and controlled in such a way that the set tidal volume V_T is delivered at a minimum airway pressure for a given patient lung compliance while avoiding pressure peaks.

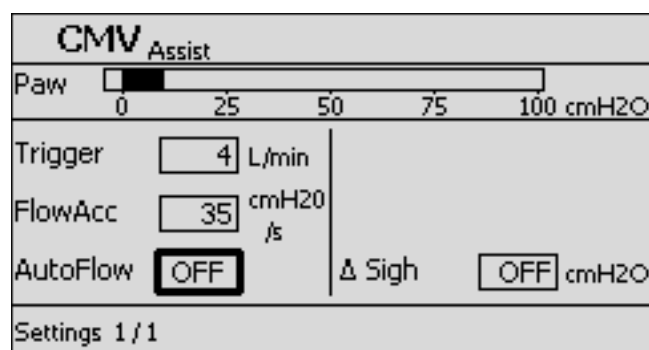
Savina supplies additional inspiratory flow during spontaneous inspirations – limited by the alarm threshold $V_{Ti} \sqrt{P}$.

The patient can also exhale during the inspiratory plateau phase.

Inspiratory pressure is limited by the alarm threshold for $Paw \sqrt{P}$.

To switch AutoFlow ON and OFF

- Press »Settings ▢▢« key.
- Turn dial knob to select item »AutoFlow« on screen.
- Press dial knob to release »AutoFlow« for setting.
- Turn dial knob to set »AutoFlow ON«.
- Press dial knob to confirm.



To set **alarm limits**, see page 64.

* For a detailed description of AutoFlow, see page 130

SIMV, SIMV / PS

Synchronized Intermittent Mandatory Ventilation*
Pressure Support**

Fixed mandatory minute volume MV set with tidal volume VT and ventilator rate f. Between mandatory ventilator breaths, the patient can breathe spontaneously, thereby contributing to the minute volume. Spontaneous breathing can be augmented with Pressure Support.

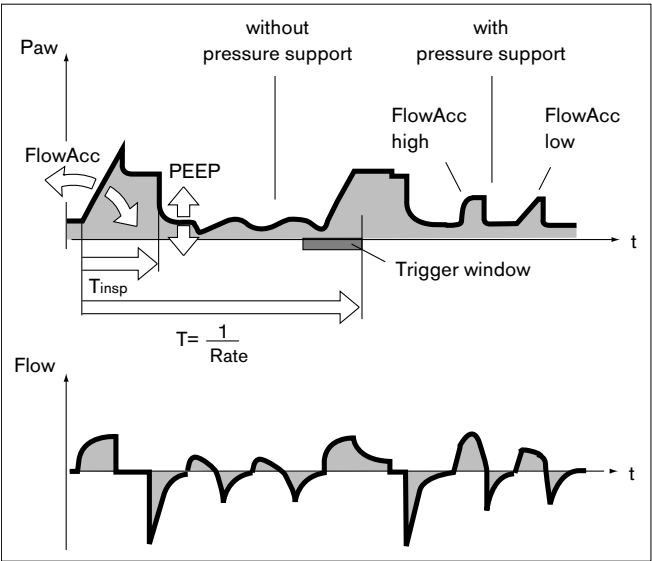
Used for patients with insufficient spontaneous breathing or for patients being weaned from artificial ventilation by stepwise reducing the mandatory portion of the total minute volume.

Set SIMV with the following ventilation parameters:

- Tidal volume »VT«,
- Inspiratory time »Tinsp«,
- Ventilator rate (frequency) »Rate«,
- O2 concentration »O2«,
- Positive end-expiratory pressure »PEEP«.

The following parameters are set on screen:

- Sensitivity »Trigger« (for synchronizing mandatory ventilator breaths) on screen page »Settings 1/1«, see page 56.
- Flow delivery, controlled by parameter "Flow Acceleration" »FlowAcc« on screen page »Settings 1/1«.
- AutoFlow ON/OFF



SIMV			
Paw	0 25 50 75 100 cmH2O A		
Trigger	4 L/min	VTApnea	500 mL
FlowAcc	35 cmH2O /s	fApnea	12 bpm
AutoFlow	OFF		
Settings 1 / 1			

* For a detailed description of SIMV, see page 132.
** For a detailed description of PSupp, see page 133.

Pressure limit Pmax

A pressure limit may be set in SIMV in order to avoid pressure peaks. In doing so, PLV (Pressure Limited Ventilation) is accomplished.

To set the pressure limit Pmax:

- Turn pressure limit ON, see page 82.
- Set the pressure limit with »Pinsp« key.

When setting the pressure limit, ensure that the tidal volume VT is still delivered, otherwise Savina will generate the message "VT low". In this case:

- Set a higher pressure limit with »Pinsp« key,
or
- increase inspiratory time »Tinsp«,
or
- increase »FlowAcc«.

SIMV			
Paw	<div> <div></div> <div>0</div> <div>25</div> <div>50</div> <div>75</div> <div>100</div> <div>cmH₂O</div> </div>		
Trigger	<div>4</div> L/min	VTApnea	<div>500</div> mL
FlowAcc	<div>35</div> cmH ₂ O /s	fApnea	<div>12</div> bpm
AutoFlow	<div>OFF</div>		
Settings 1 / 1			

12637222

Additional ventilation mode extensions

- Pressure support » ΔP_{supp} above PEEP«
- Apnea ventilation
(For setting apnea ventilation, see page 62.)

Operation

PCV+ (BIPAP), PCV+ / PS (BIPAP/PS)

PCV+ (BIPAP), PCV+ / PS (BIPAP/PS)

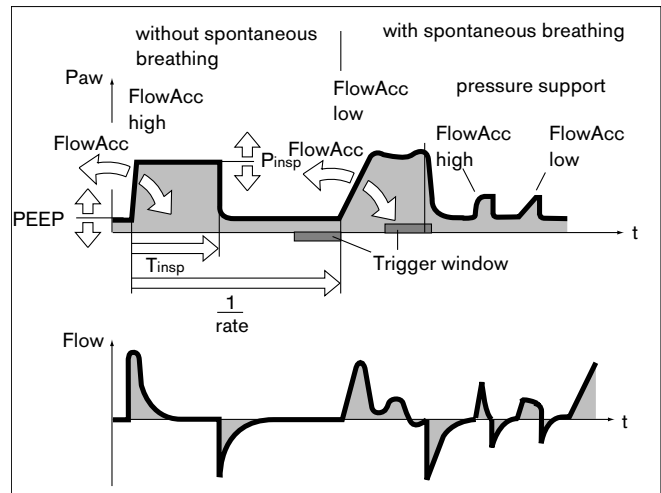
(Available Option)

Biphasic Positive Airway Pressure
Pressure Support

Pressure-controlled ventilation combined with free spontaneous breathing during the complete breathing cycle, supported by adjustable additional pressure at CPAP level. The mandatory portion of the total minute volume MV is set with parameters inspiratory pressure P_{insp} , PEEP, and ventilator rate (frequency).

Adaptable to a wide range of patients, from those unable to breathe spontaneously at all to those breathing spontaneously before extubation. Suitable for weaning patients from artificial ventilation by progressively reducing the mandatory portion of minute ventilation MV and by reducing pressure support $\Delta P_{supp.}$ above PEEP.

For details refer to "Pressure support" on page 133.



Set PCV+ pattern with the ventilation parameters:

- Inspiratory time »**T_{insp}**«,
- Ventilator rate (frequency) »**Rate**«,
- O₂ concentration »**O₂**«,
- Inspiratory pressure »**P_{insp}**«,
- Positive end-expiratory pressure »**PEEP**«.

The following parameters are set on screen:

- Sensitivity »**Trigger**« (for synchronization with spontaneous breathing)
- Flow acceleration »**FlowAcc**«,
set on screen page »**Settings 1/1**«
The flow acceleration setting is in effect for both PCV+ bi-level breaths and pressure support » **$\Delta P_{supp.}$ above PEEP**«.

PCV+ may also be supplemented with the following ventilation mode extensions and parameters:

- Pressure support
» **$\Delta P_{supp.}$ above PEEP**« (PCV+ / P_{supp.})
- Apnea ventilation
To set apnea ventilation, see page 62.

To set **alarm limits**, see page 64.

CPAP, CPAP / PS

Continuous Positive Airway Pressure
Pressure Support

Used for patients with adequate spontaneous breathing.

Spontaneous breathing at an elevated pressure level, to increase a patient's functional residual capacity FRC. Spontaneous breathing can be assisted with additional pressure support.

Set CPAP with the following ventilation parameters:

- O₂ concentration »O₂«
- Positive end-expiratory pressure »PEEP«

Additionally, for CPAP/PS:

- Pressure support » Δ Psupp. above PEEP«

The following parameters are set on screen:

- Flow acceleration »FlowAcc« for pressure support P_{Supp}. on screen page »Settings 1/1«
- Sensitivity »Trigger« (for synchronizing spontaneous breathing efforts with pressure support) on screen page »Settings 1/1«.

CPAP, CPAP/ASB may be supplemented with the following ventilation mode extensions and parameters:

- Trigger
By setting a trigger sensitivity, the assisting ventilator breaths are synchronized with the patient's own spontaneous breathing efforts.
Activating/setting trigger, see page 56.
- Apnea ventilation
To set apnea ventilation, see page 62.

To set **alarm limits**, see page 64.

Apnea Ventilation

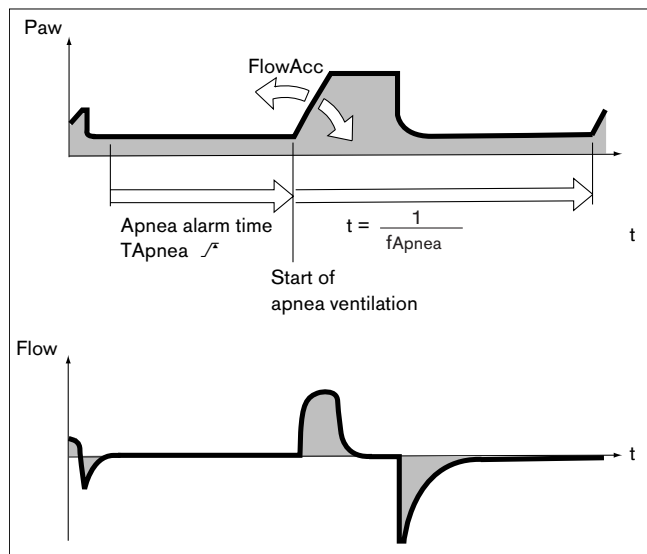
Performs automatic switchover to volume-controlled mandatory ventilation in the event of an apnea. Apnea ventilation may be used with all ventilation modes that work with spontaneous breathing. If the patient stops breathing spontaneously, Savina activates an alarm after the set alarm time (T_{Apnea} $\sqrt{\Delta}$) and starts volume controlled ventilation with

– I:E ratio of 1:2

and the set ventilation parameters:

- ventilator rate (frequency) »fApnea«
- tidal volume »VTApnea«

The patient can breathe spontaneously during apnea ventilation at any time. Apnea ventilation frequency »fApnea« remains constant.



To set apnea ventilation

- Press »Settings $\triangleright \triangleleft$ « key to display screen page »Settings 1/1«.

With apnea ventilation switched on, the fields »VTApnea« and »fApnea« are visible.

On the main screen page, "A" = Apnea Ventilation Standby appears to the right of the waveform.

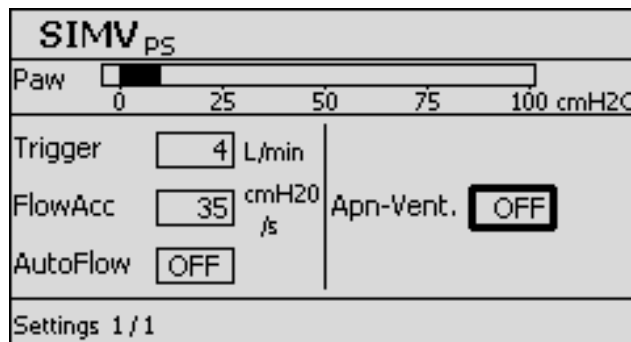
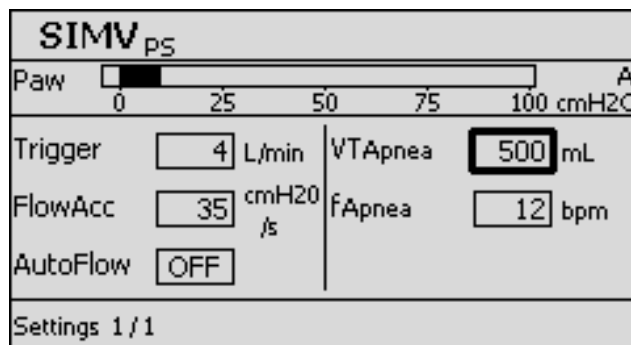
If apnea ventilation is switched off, »Apn.-Vent. OFF« will be showing,

To switch apnea ventilation on:

- Turn dial knob to select screen field »Apn.-Vent. OFF«.
- Press dial knob to activate apnea ventilation.
- Turn dial knob to select a value of at least 2 bpm, the fields »VTApnea« and »fApnea« will become visible.
- Select screen fields by turning dial knob again, press dial knob to activate.
- Turn dial knob to adjust value, press dial knob to confirm.

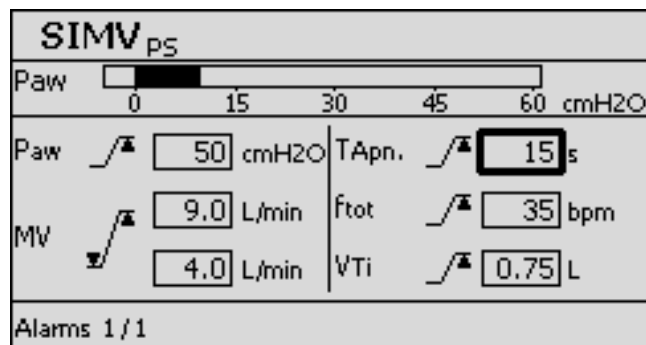
To deactivate apnea ventilation:

- Turn dial knob to select a value lower than 2 in the field »fApnea«, and press dial knob to confirm.



Setting apnea delay time T_{Apnea} $\sqrt{\Delta}$ in the "Alarms" screen page

- Press **»Alarms** $\triangleright \triangleright$ key to display screen page **»Alarms 1/1«**
Turn dial knob to select field **» T_{Apnea} $\sqrt{\Delta}$ «,**
press dial knob to activate.
- Turn control knob to adjust value,
press dial knob to confirm.

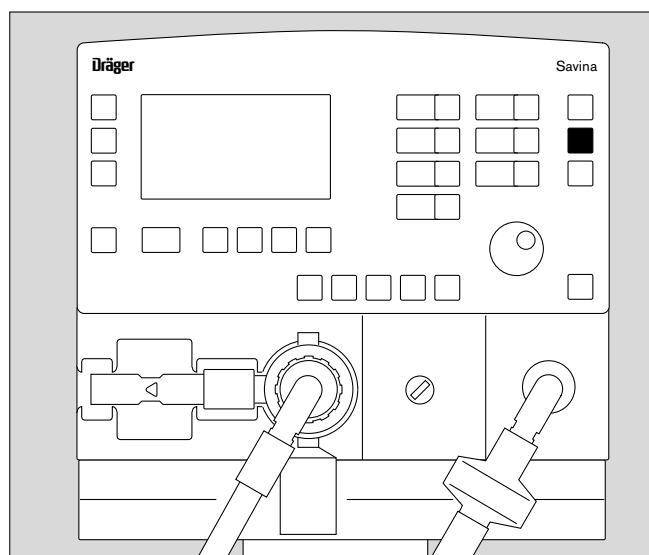


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To end apnea ventilation:

- Press **»Alarm Reset«** key.

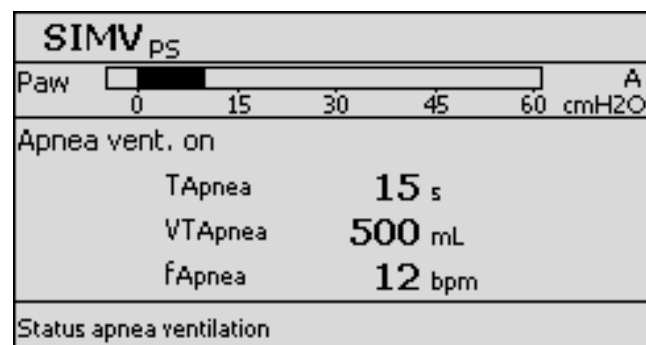
The ventilator will continue to ventilate in the original ventilation mode with the associated ventilation parameters set for that mode.



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When settings are adjusted on the ventilator, the status of apnea ventilation is displayed on a special info screen page for 6 seconds in all those cases where apnea ventilation would be possible in principle:

- when switching between ventilation modes,
- when switching Savina on,
- when, by reducing the ventilator frequency, the cycle time becomes longer than the current value of T_{Apnea} $\sqrt{\Delta}$,



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To set alarm limits, see page 64 .

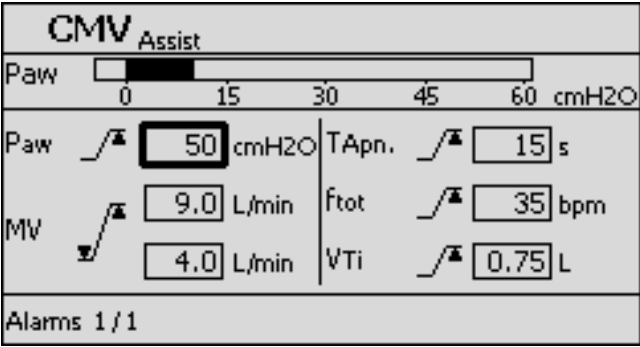
Setting Alarm Limits

- Press »Alarms >>« key.

Example display: screen page »Alarms1/1«

This page displays all alarm limits that can be set.
↙ = lower alarm limit
↗ = upper alarm limit

Alarm	Setting Range
Paw ↗	10 to 100 cmH2O
MV ↗	2. to 41 L/min
MV ↙	0.5 to 40 L/min
TApnea ↗	15 to 60 sec
ftot ↗	10 to 120 bpm
VTi ↗	0.06 to 4 L



Example: Setting the upper alarm limit for Paw.

- Turn dial knob to select field »Paw ↗« on screen, press dial knob to activate for setting.
- Turn dial knob to adjust value, press dial knob to confirm.

For airway pressure Paw the lower alarm limit does not have to be set, because it is automatically linked to the PEEP setting.

For the O2 concentration, no alarm limits have to be set, because they are automatically linked to the setting of O2 concentration:

Lower alarm limit:
Setpoint – 4 Vol.% (for setpoints up to 60 Vol.%)
Setpoint – 6 Vol.% (for setpoints from 60 to 100 Vol.%)
Upper alarm limit:
Setpoint + 4 Vol.% (for setpoints up to 60 Vol.%)
Setpoint + 6 Vol.% (for setpoints from 60 to 100 Vol.%)

Operation at High Ambient Temperature

The low priority alarm »! Temperature high« occurs if the ambient temperature is above 30 °C. In this case, the maximum number of rotations of the blower needs to be restricted in order to reduce the heat transfer to the breathing gas. The higher the ambient temperature becomes, the more the maximum number of rotations is reduced. This implies that at very high inspiratory pressure (e. g. $P_{insp} = 80 \text{ cmH}_2\text{O}$), higher peak flows like e. g. 180 L/min can not be reached. However, depending on the set ventilation parameters, the blower built into Savina still increases the breathing gas temperature to some extent. To avoid dangerous temperatures, a minimal inspiratory tube length of 1.1 m is required. This insures a breathing gas temperature below 41 °C at the y-piece as the breathing gas is sufficiently cooled down. If due to reasons not covered by these measures the breathing gas temperature measured by the internal temperature sensors is found to be higher or equal 40 °C, Savina sets the high priority alarm »!!! Temperature high«, but continues ventilation. If an external (optional) temperature sensor is used, the alarm »!!! Breathing gas temp. high« is displayed.

When using the temperature sensor AWT 01:

- Only use sensors with blue leads.

In the Event of an Alarm

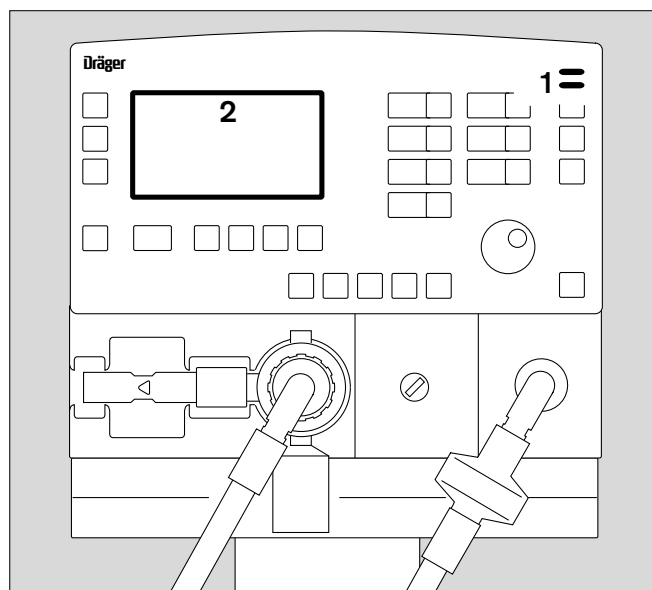
- 1 The red or yellow LED will begin to flash.
- 2 An alarm message will be displayed in the right-hand corner of the top line of the screen.

Savina assesses the alarm message according to its priority, marks the text with exclamation marks corresponding to the alarm level and generates a different alarm tone sequence for each level.

WARNING !

Warning or Caution level audible alarms require immediate operator attention to avert or to prevent development of situations with the possibility of patient injury

- !!! = Warning (red LED flashes)
- !! = Caution (yellow LED flashes)
- ! = Advisory (yellow LED lights up and remains continuously lit)



Alarm Categories

Warning

Top priority message

1 Red LED flashes.

Warning messages are marked with three (3) exclamation marks.

Example: !!! **Apnea**

Savina generates a five-tone sequence that sounds twice and is repeated every 7.5 seconds as the warning-level audible alarm.

Caution

Medium priority message

1 Yellow LED flashes.

Caution messages are marked with two (2) exclamation marks.

Example: !! **Check settings**

Savina generates a 3-tone sequence that is repeated every 20 seconds as the caution-level audible alarm.

Advisory

Low priority message

1 Yellow LED lights up and remains lit.

Advisory messages are marked with one exclamation mark.

Example: ! **Flow monitoring inactive**

The corresponding audible alarm Savina generates is a two-tone sequence that sounds only once.

To remedy any faults, please refer to the "Troubleshooting" section starting on page 102.

Once a fault has been remedied

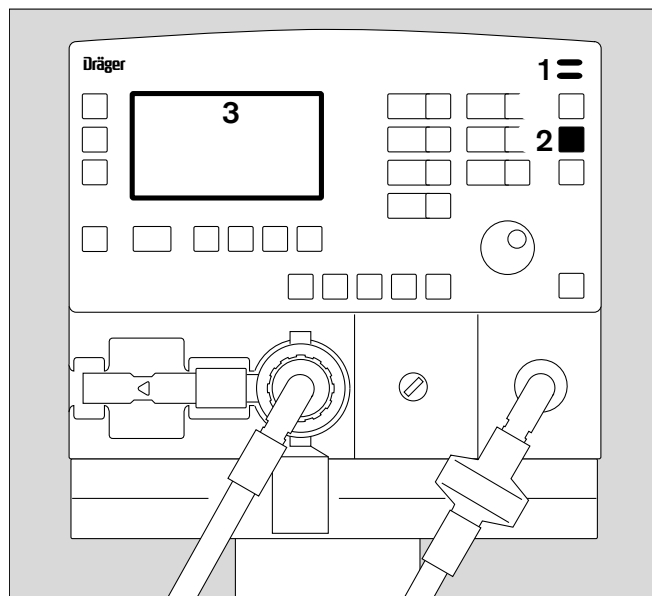
The audible alarm will be switched off.

Caution (!!) and Advisory (!) messages will disappear automatically from the screen.

Warning (!!!) messages remain displayed black on white on screen and must be acknowledged:

2 Press »**Alarm Reset**« key

3 The message is erased from the screen.



Silencing Audible Alarms

for a maximum of 2 minutes:

- 1 Press »**Alarm Silence**« key. Its yellow indicator LED will light up and the alarm tone will be muted for about 2 minutes. If the fault that triggered the alarm persists, the audible alarm will start again after that time.

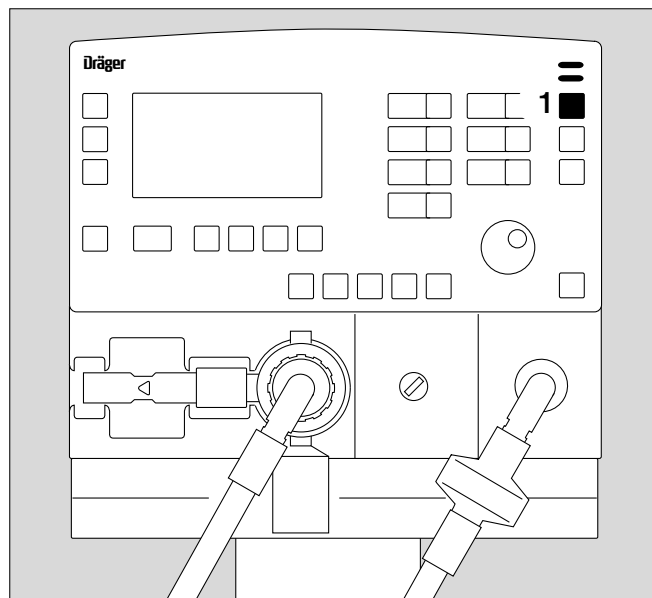
WARNING !

The alarm silence key is intended to provide a way of muting audible alarms while corrective action is taken. The operator of the ventilator must still assume responsibility for proper ventilation and patient safety in the event of an alarm. Failure to identify and correct alarm situations may result in patient injury.

If you wish to rearm the audible alarm before the end of the 2-minute silencing period:

- 1 Press »**Alarm Silence**« key again. The yellow LED will now go out. The message remains on the screen.

If a higher priority alarm occurs while the audible alarm is muted, the audible alarm will sound only once.



Operation

In the Event of a Gas Supply Failure

In the Event of a Gas Supply Failure

In normal ventilation, Savina ventilates with ambient air via a turbine blower system and with O₂ from a medical gas pipeline system or from a cylinder.

In the event of O₂ failure

Savina substitutes the missing fraction of inspiratory O₂ with ambient air and generates an alarm.

Minute volume remains constant.

The inspiratory O₂ concentration FiO₂ drops to 21 Vol.%

If the patient needs an inspiratory O₂ concentration higher than 21 Vol.%:

- Reconnect to a working O₂ supply without delay.

In the event of a blower failure

WARNING !

In the event of a failure of the turbine blower, Savina is not able to continue ventilation. Immediately continue ventilation using an independent manual ventilation device (resuscitation bag) in this case.

NOTE: Spontaneous breathing is possible at any time.

Displaying Waveforms and Measured Values

On the main page

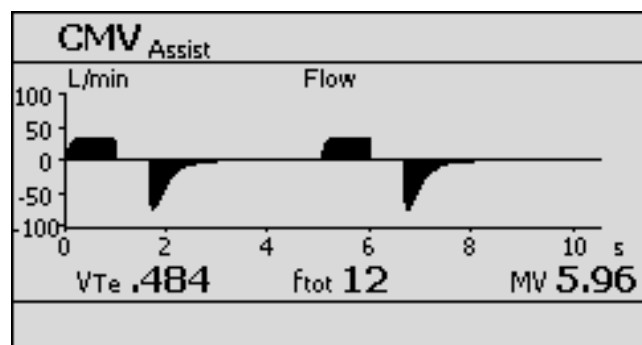
airway pressure waveform or flow waveform and three relevant measured values are displayed

To change the waveform display

- Press »Waveforms  key.

Example: flow waveform

The combination of measured values to be displayed in the measured values screen field is configurable, see page 79.



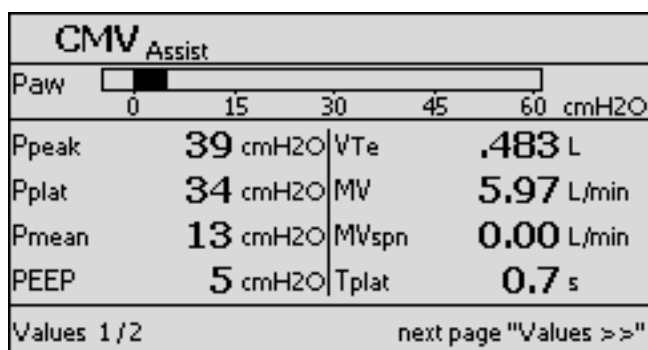
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Displaying Measured Values

- Press »Values  key. The screen page »Values 1/2« appears.


Airway pressure is displayed as a bar graph.

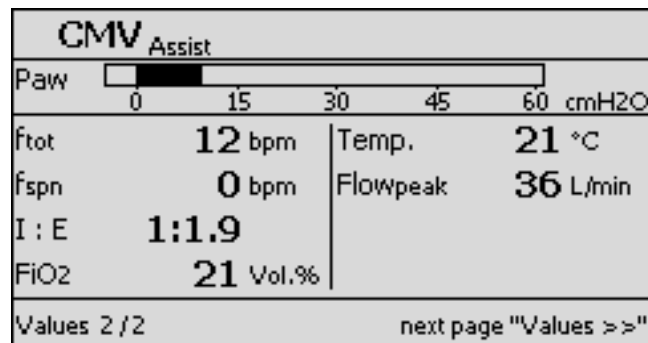
The other measured values are displayed numerically.



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Displaying other measured values

- Press »Values  key again. The screen page »Values 2/2« appears.



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Special Functions

Manual inspiration

This function is accessible in all modes except CPAP spontaneous breathing without pressure support. Regardless of the start time, an automatic ventilator breath can be prolonged up to a maximum of 15 seconds.

Or:

Between two automatic ventilator breaths, a manual breath can be started and held for a maximum of 15 seconds.

The pattern of the manually started ventilator breath depends on the ventilation mode in use.

For CMV, SIMV:

volume controlled ventilator breath, defined by the »VT« and »T_{insp}« settings.

For PCV+:

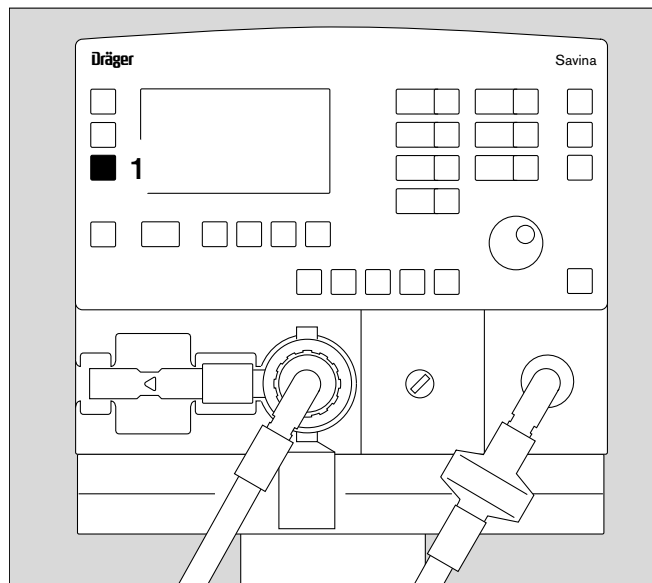
pressure controlled ventilator breath, defined by the »P_{insp}« and »T_{insp}« settings.

For CPAP/PS:

pressure-assisted ventilator breath, defined by the » Δ P_{supp.} above PEEP« setting.

- 1 Press and hold down »**Insp. hold**« key for as long as inspiration is desired.

Either an automatic ventilator breath that has just begun will be prolonged as long as the key is held down, or a new ventilator breath will be started and extended for as long as the key is held down, in each case for a maximum of 15 seconds.



Nebulizing Medicated Aerosols

Applicable in every ventilation mode.

NOTE: Use of the nebulizer port will only be available with a connected O₂ supply between 39 and 87 psi (2.7 to 6 bar).

Savina applies the medicated aerosol in synchronization with inspiration, i.e., only during the inspiratory flow phase. An inspiratory flow of 18 L/min is needed to trigger the nebulizer gas supply. Small patients, or any patient who has a low initial inspiratory flow rate will not trigger the nebulizer gas supply during the early part of the breath. Under these conditions the nebulized drug may not be distributed well to the distal airways. For this reason the nebulization mode is recommended for use only with adults and larger children under conditions when the nebulizer flow will be triggered during early inhalation.

The ventilator will also automatically maintain a constant minute-volume.

Savina automatically turns the nebulizer off after 30 minutes. The flow sensor will be automatically heat-cleaned and calibrated after the aerosol treatment to prevent artifacts during flow measurement.

WARNING !

Never use flammable medications (e.g. on the basis of ethanol). Fire hazard!

WARNING !

Since Savina uses pure oxygen for nebulizing medicated aerosols, an increase of the set inspiratory O₂ concentration may be caused

Due to the inability of Savina to measure this increase in the O₂ concentration, an incorrect O₂ reading will be displayed.

- Connect your O₂ supply of 39 to 87 psi (2.7 to 6 bar) – from the medical O₂ pipeline system or from a cylinder, to the Savina ventilator (side panel).
- Prepare the nebulizer in accordance with its accompanying instructions for use

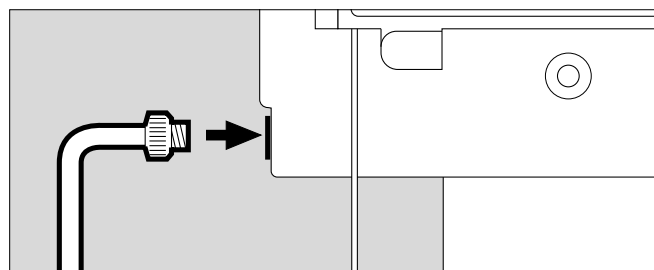
- 1 Connect nebulizer to the inspiratory side of the wye (temperature sensor side).

WARNING !

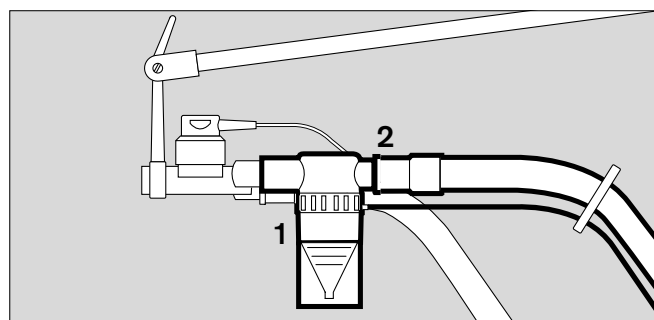
The integrated nebulizer function of Savina is designed for nebulizers with a nebulizing flow of 6 L/min at 29 psi (2 bar), for example nebulizer 84 12 935 (white central body).

Use of other pneumatic nebulizers may result in considerable discrepancies in the minute-volume reading!

- 2 Connect inspiratory circuit to the nebulizer.



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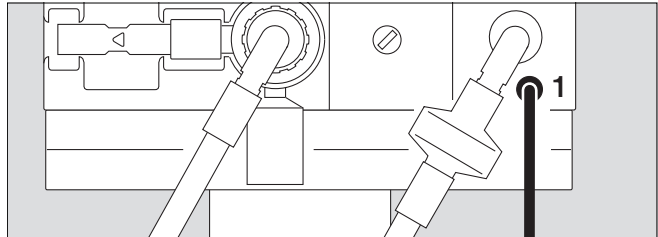


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Operation

Nebulizing Medicated Aerosols

- Swivel nebulizer to the vertical position.
 - Using clamps, route the nebulizer hose back to the ventilator along the patient circuit.
- 1 Connect the nebulizer hose to the small nozzle on the front of Savina.
- Fill nebulizer in accordance with its accompanying instructions for use.




- 2 Hold down »  **Nebul.**« key, until the yellow light is illuminated.

On-screen advisory message:
! Nebulizer on

The nebulizer is in operation for 30 minutes; nebulization occurs only in the inspiratory flow phase.

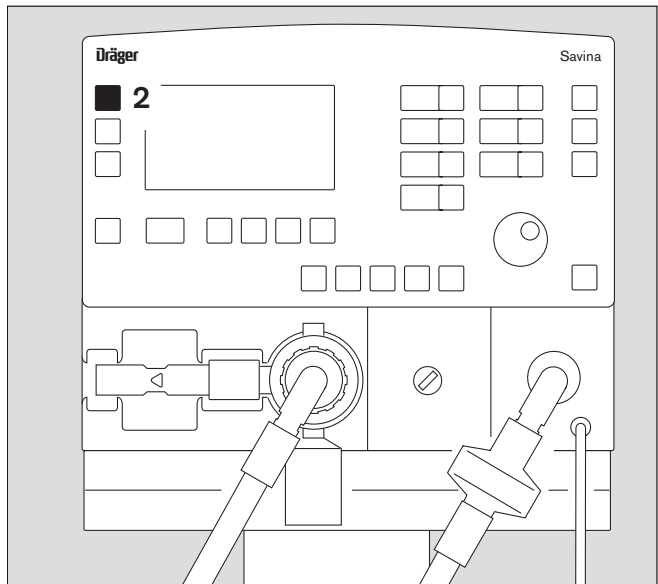
If nebulization needs to be stopped prematurely:

- 2 Press »  **Nebul.**« key again. The yellow light goes out, the nebulizer is switched off.

Savina will automatically heat-clean and calibrate the flow sensor.

On-screen information:
Flow calibration

- Remove any leftover medication from the nebulizer.
- Follow nebulizer instructions for use for this procedure.



WARNING !

Consider effects of aerosols on sensors, filters, and heat and moisture exchangers (HMEs)!

The measuring function of the flow sensor may be impaired.

The flow resistance of filters is liable to increase and may impair ventilation.

Do not put a microbial filter on the nebulizer outlet when in use!

WARNING !

Do not use a heat/moisture exchanger simultaneously with a nebulizer or heated humidifier!

Risk of increased breathing resistance due to condensation.

Pre-/Post-Oxygenation for Bronchial Suction

NOTE: This feature will only be available with a connected O₂ supply between 2.7 to 6 bar (39 to 87 psi).

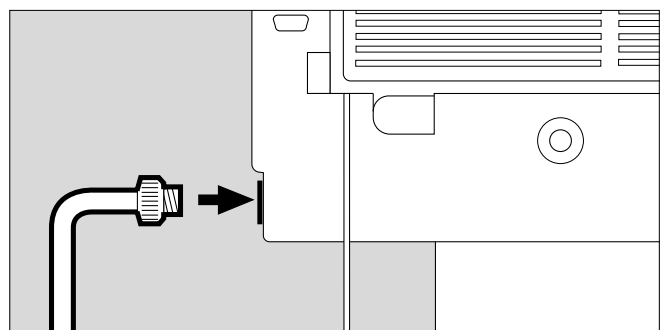
To prevent hypoxia during bronchial suction, Savina is provided with an oxygenation program to be used during removal of secretions.

After the program has started, Savina ventilates in the selected ventilation mode for up to 180 seconds with 100 Vol.% oxygen as a pre-oxygenation phase.

When the ventilator is disconnected for suction, Savina automatically interrupts ventilation. During the suction phase, the audible alarms are suppressed so that the suction routine is not disrupted.

After suction and the automatically recognized reconnection, Savina ventilates 120 seconds with 100 Vol.% O₂. During suction, and for two minutes afterwards, the lower alarm limits for both the minute volume and airway pressure alarms are disabled.

- Connect your O₂ supply 2.7 to 6 bar (39 to 87 psi) – from the medical O₂ pipeline system or from a cylinder, to the side of Savina.



Before suction

- 1 Hold down »O₂ ↑ suction« key until the yellow lamp lights up.
- 1 Savina now ventilates with 100 Vol.% O₂ in the set ventilation mode.
In case PEEP has not been set higher than 4 cmH₂O, an automatic setting of 4 cmH₂O will be applied.
This PEEP will enable Savina to detect any subsequent disconnection. All other ventilation parameters remain unchanged.

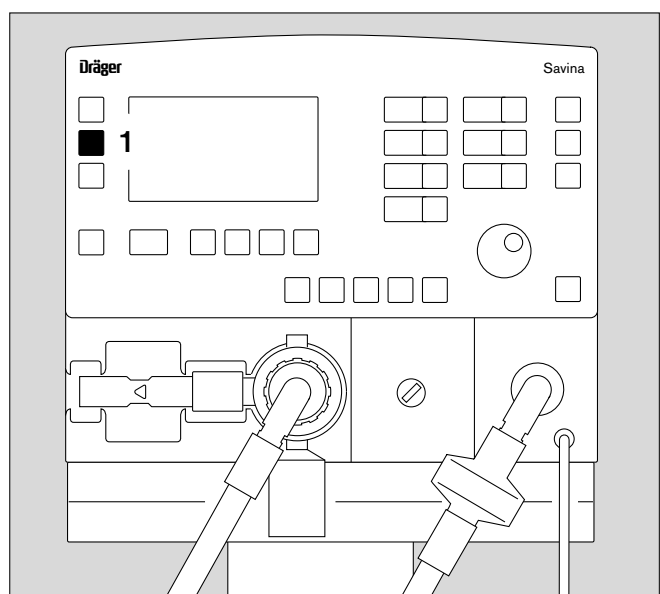
Message in the information line on screen:

O₂ enrichment 100 % 180 s

The time remaining for pre-oxygenation is continuously displayed on screen.

Pre-oxygenation lasts for a maximum of 180 seconds. During this time, Savina waits for a disconnection associated with the begin of suction.

If there is no disconnection after 180 seconds, Savina will terminate the oxygenation program.



Operation

Pre-/Post-Oxygenation for Bronchial Suction

After disconnecting patient for suction

During the period of disconnection, Savina supplies a minimal flow of 100 Vol.% O₂ in order to automatically detect the end of the disconnection phase. The time available for suction is continuously displayed on screen in the information line, (example):

Execute suction and reconnect 120 s

If suction is ended and the system is reconnected within the displayed time, Savina begins post-oxygenation. The alarms for the lower alarm limit \dot{V}_{total} \searrow and upper alarm limit P_{aw} \nearrow will be suppressed.

After reconnection

After reconnection has taken place, Savina ventilates again in the set ventilation mode, however, for the purpose of post-oxygenation, 100 Vol.% O₂ are used for another 120 seconds.

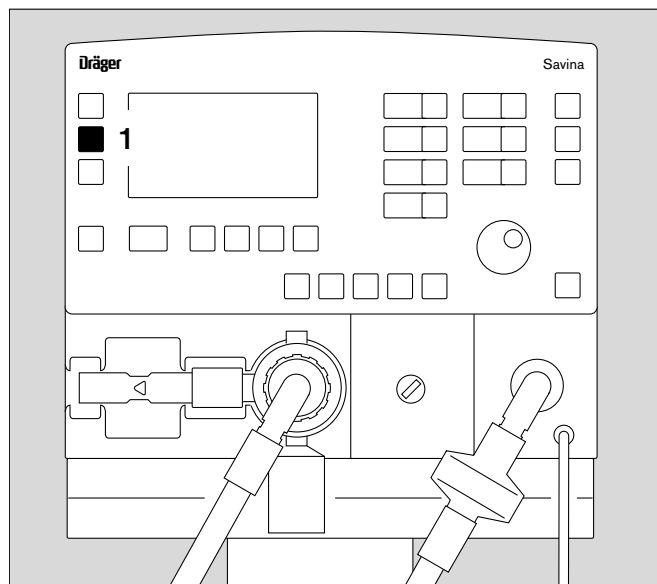
Message in the information line on screen:

Final O₂ enrichment 100 % 120 s

The remaining time is continuously displayed on screen.

In case the oxygenation program has to be interrupted:

- 1 Press the »O₂ \uparrow suction« key again



Automatic discontinuation of the oxygenation program

If no reconnection has followed after 120 seconds, Savina stops the oxygenation program. All alarms are immediately reactivated. Savina immediately continues ventilating in the set ventilation mode.

Calibrations

Calibration / zeroing values are saved and remain stored even when the ventilator is switched off.

Automatic calibration of the pressure sensors

The pressure sensors for measuring airway pressure are calibrated automatically.

Automatic calibration of the flow sensor

The flow sensor will be automatically calibrated under the following circumstances:

- when the ventilator is switched on
- every 24 hours during operation
- after changing the flow sensor
- after using the pneumatic nebulizer
- after bronchial suction
- after changing the O₂ concentration

NOTE: Savina uses a full inspiratory phase for calibration. Short inspiratory times are extended to approximately one second.

Message in the information line on the screen:

Flow calibration in progress

After calibration is complete, the following message should appear in the information line:

Flow calibration ok

If the attempt at calibration was not successful, the display will show:

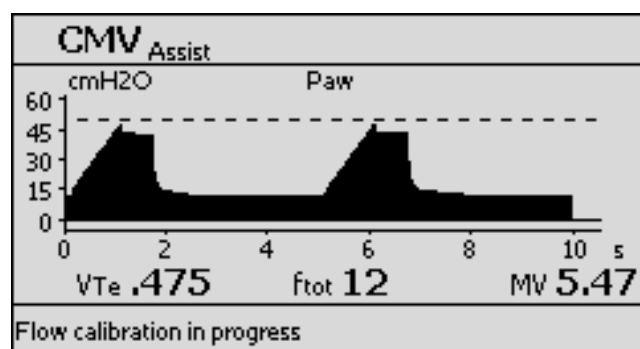
Flow calibration failed

The expiratory portion of the flow waveform will not be showing on screen and no measured values for V_{Te}, MV and PEEP will be displayed.

Then:

- Exchange flow sensor

NOTE: Without an usable flow measurement neither the O₂ calibration nor the pre-/post-oxygenation during bronchial suction is possible. For this routine, the breathing phase recognition of the flow measurement is required.



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WARNING !

Always pay special attention to the success of a flow calibration. The operator of the ventilator must still assume responsibility for proper ventilation and patient safety in the event of a loss of expiratory flow monitoring. Replace a faulty flow sensor as soon as possible.

Calibrating O2 Sensors

Savina uses two O2 sensors. One for O2 control and monitoring of the O2 concentration (sensor 1). A second O2 sensor (sensor 2) is used to verify the measurement of sensor 1.

The O2 sensor for O2 control and display (sensor 1) is automatically calibrated by Savina:

- after 8 hours of operation
- when sensor 2 is calibrated
- when the O2 sensor is replaced
- if readings from sensor 1 and 2 differ from each other by more than 2 % by volume
- when the air pressure changes by more than 200 hPa, e.g. during helicopter transports
- after a change in temperature of more than 10 °C (18 °F).

During automatic calibration, the following message will appear in the information line on the screen:

O2 calibration in progress

After calibration is complete, the following message should appear:

Calibration ok

Sensor 2 has to be calibrated manually:

- once per month.
or
- if the following alarm occurs:
!!! O2 measurement failure

Manual calibration may be performed in any ventilation mode, see page 80.

Configuration

Setting the Screen Contrast	78
Adjusting the Volume of the Audible Alarm	79
Configuring the Measured Values Field	79
Manual Calibration for O ₂ Sensor 2	80
FiO ₂ - or Flow Monitoring ON / OFF	81
Pmax ON/OFF	82
Pressure Plateau ON / OFF	82
Selecting the Language	83
Setting Date and Time	83
Configuring the MEDIBUS Protocol	84
Displaying Ventilator Data	84

Configuration

The following user preferences can be selected in »**Configuration**« mode:


- Screen contrast
- Audible alarm volume
- Measured values field
- Manual calibration for O₂ sensor 2
- FiO₂ and flow monitoring ON / OFF
- Pmax ON / OFF
- Plateau ON/OFF
- Language, date and time
- MEDIBUS communication protocol

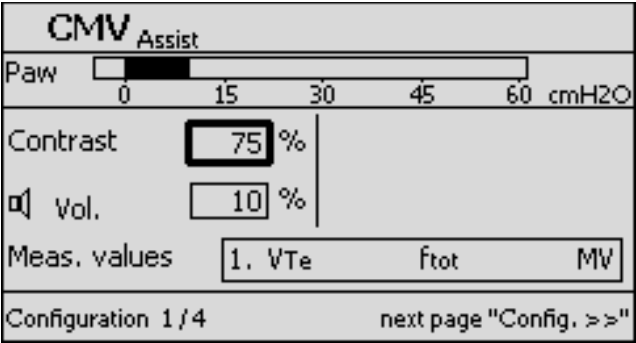
The settings selected in »**Configuration**« mode remain stored even when the ventilator is switched off.

The following information about the status of the ventilator can be displayed in »**Configuration**«:

- Total operating hours
- Operating hours since the last inspection and maintenance.

Setting the Screen Contrast

- Press »**Config.**  « key repeatedly until »**Configuration 1/4**« appears..
- Turn dial knob to select the item »**Contrast**«. Press dial knob to activate.
- Turn control knob to adjust the contrast. The contrast changes. Press dial knob to confirm. The set contrast is now in effect.



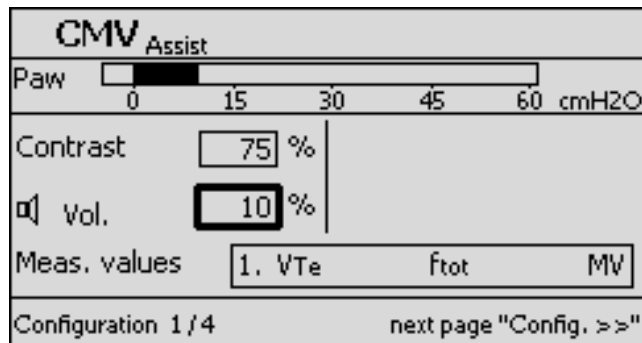
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Adjusting the Volume of the Audible Alarm

Display (example):

- Press »Config. ▷▷« key repeatedly until »Configuration 1/4« appears.
- Turn dial knob to select item »Volume«. Press dial knob to activate.
- Turn dial knob to adjust volume. Press dial knob to confirm.

After the setting has been confirmed, the audible alarm will sound once to enable you to judge the set volume.



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WARNING !

Always adjust audible alarm volume to a level that ensures the operator will be alerted when alarms occur. Failure to identify and correct alarm situations may result in patient injury.

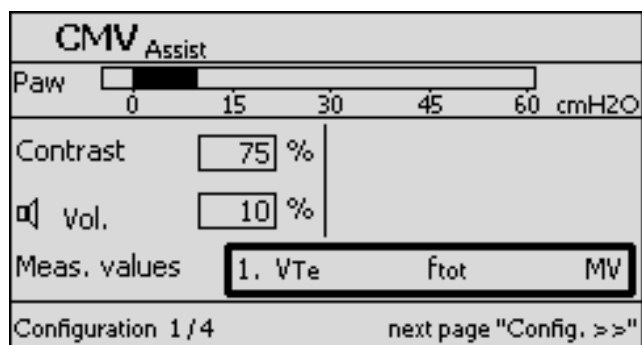
Configuring the Measured Values Field

Select one of 6 possible combinations of measured values:

- Press »Config. ▷▷« key repeatedly until »Configuration 1/4« appears.
- Turn dial knob to select item »Measured values«. Press dial knob to activate.
- Turn dial knob to select a combination of measured values. Press dial knob to confirm.

The following combinations of measured values may be selected

1.	VT _e	ftot	MV
2.	FiO ₂	VT _e	MV
3.	P _{peak}	VT _e	MV
4.	P _{mean}	FiO ₂	MV
5.	P _{mean}	VT _e	MV
6.	P _{peak}	P _{mean}	VT _e



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Manual Calibration for O2 Sensor 2

- Required when the following alarm has occurred:
!!! O2 measurement failure
or
- at least monthly.

WARNING !

Always use a reliable independent O2 supply during calibration. In case the calibration procedure is based on a diluted oxygen source, Savina may deliver inaccurate oxygen concentrations without further notification.

NOTE: Manual calibration of O2 sensor 2 may be performed in any ventilation mode.

- Before starting the calibration procedure, replace the central O2 supply with a reliable independent supply that contains 100% O2 (e. g. O2 cylinder)
- Press »Config ▢▢« key repeatedly until »Configuration 2/4« appears.
- Turn dial knob to select item »O2 calib.«. Press dial knob to release for setting.
- To start O2 calibration, turn dial knob and select »Start«. Press dial knob to confirm.

Message in the information line at the bottom of the screen:
Disconnect patient

- Disconnect patient within the next 30 seconds.
- If necessary, continue ventilating the patient using a separate ventilating device.

Message in the information line at the bottom of the screen:
O2 calibration active

After 60 seconds the following appears in the information line:
Reconnect patient

- Immediately reconnect patient.

NOTE: If necessary, the patient may be reconnected at any time. Savina will ventilate as before. Message:

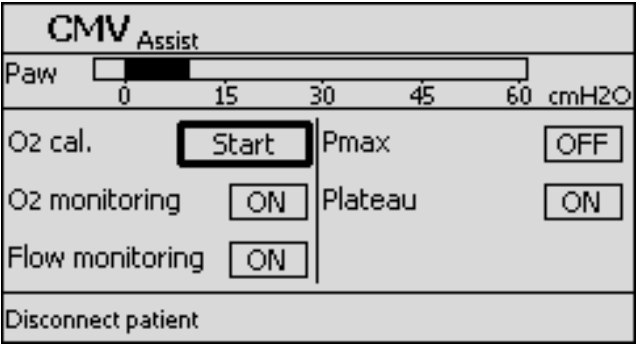
O2 calibration interrupted
In this case, the ventilator continues to operate using the old calibration values.

Thereafter appears:

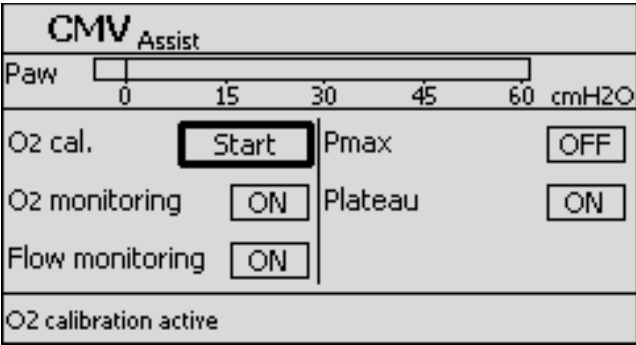
O2 calibration OK
Reconnect Savina to the original O2 source

The O2 calibration is completed, Savina ventilates again using the original settings.

NOTE: Disconnection during the calibration procedure would activate a number of alarms. For this reason, Savina turns the respective alarms off during calibration.
If the patient is not reconnected, all alarms become active again. Savina continues ventilation with the original settings.



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If the following alarm appears after calibration:

!!! O2 measurement failure

- Replace O2 sensor, see page 98.

If the following alarm appears after calibration:

!!! FiO2 low

- Make sure, that the O2 source in use contains 100 % O2.

FiO2- or Flow Monitoring ON / OFF

For instance, when a used up O2 or flow sensor cannot be replaced immediately.

WARNING !

In case of a fault in any of the built-in monitoring a substitute has to be provided in order to maintain an adequate level of monitoring. The operator of the ventilator must still assume full responsibility for proper ventilation and patient safety in all situations.

- Press »Config. $\triangleright\triangleright$ « key repeatedly until »Configuration 2/4« appears.
- Turn dial knob to select desired field.
Press dial knob to confirm selection.
- Turn dial knob to select »ON«.
Press dial knob to confirm.
The respective monitoring is now activated.
- Turn dial knob to select »OFF«.
Press dial knob to confirm.

The corresponding monitoring parameter (O2 or Flow) and all associated alarms are now permanently deactivated.

Display in the alarm field:

! Flow monitoring off

or

! O2 monitoring off

Display in the information field:

Use external flow monitoring

or

Use external monitoring

or

Use external flow- and O2 monitoring

respectively.

NOTE: Flow monitoring is automatically activated at each start of the ventilator.

NOTE: Even when O2 monitoring is deactivated, the ventilator requires at least Sensor 1 for accurate O2 control, otherwise the blending of O2 and Air would be impaired.

CMV Assist

Paw 0 15 30 45 60 cmH2O

O2 cal. **Start** Pmax **OFF**

O2 monitoring **ON** Plateau **ON**

Flow monitoring **ON**

Reconnect patient

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CMV Assist

Paw 0 15 30 45 60 cmH2O

O2 cal. **OFF** Pmax **OFF**

O2 monitoring **ON** Plateau **ON**

Flow monitoring **ON**

Configuration 2 / 4 next page "Config. >>"

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Configuration

P_{max} ON / OFF

Pressure Plateau ON / OFF

O₂ monitoring should only be deactivated when Savina is supplied with air only.

NOTE: O₂ monitoring remains deactivated even when the ventilator is switched on again.

In the alarm field, a caution level message will appear:

!! O₂ monitoring off

After acknowledging by pressing the »Alarm Reset« key, the advisory message is:

! O₂ monitoring off

When flow monitoring is deactivated, the following measured values are no longer determined:

- MV
- MV_{spont}

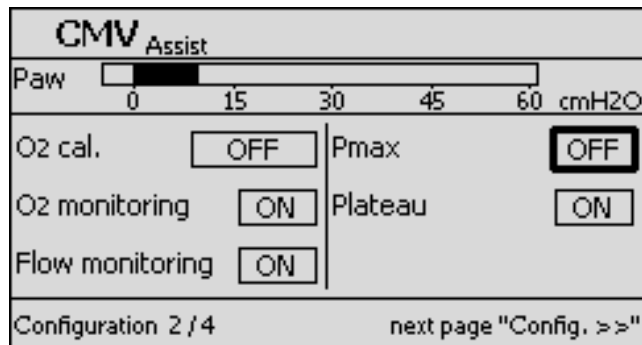
- Reactivate flow monitoring after replacing the flow sensor.

P_{max} ON / OFF

To use the pressure limit P_{max} in the CMV, and SIMV, SIMV/PS ventilation modes.

The pressure limit value is set with the »P_{insp}« key. Savina limits the airway pressure to that threshold.

- Press »Config. ▷▷« key repeatedly until »Configuration 2/4« appears.
- Turn dial knob to select item »P_{max}«. Press dial knob to activate.
- Turn dial knob to select »ON«. Press dial knob to confirm. Pressure limit »P_{max}« is now switched on.
- Turn dial knob to select »OFF«. Press dial knob to confirm. Pressure limit »P_{max}« is now switched off.

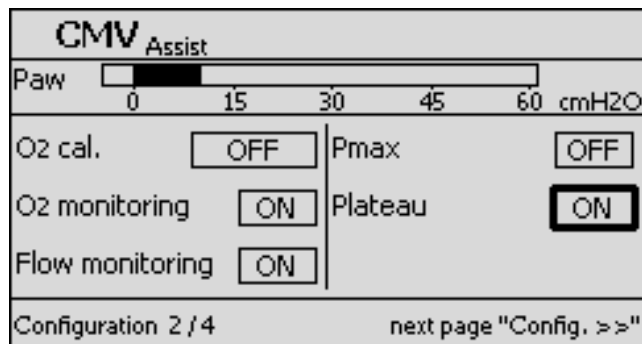


Pressure Plateau ON / OFF

To switch inspiratory pause ON or OFF.

When the pressure plateau setting is deactivated, Savina will switch to expiration as soon as the tidal volume is applied. A setting of inspiratory time T_{insp} will not be applied. The resulting I:E ratio will be limited to a maximum of 4:1. A minimum expiratory time of 500 ms is also guaranteed.

- Press »Config. ▷▷« key repeatedly until »Configuration 2/4« appears.
- Turn dial knob to select »Plateau« field. Press dial knob to activate.



- Turn dial knob to select »ON«.
Press dial knob to confirm.
Plateau is now switched on.
- Turn dial knob to select »OFF«.
Press dial knob to confirm.
Plateau is now switched off.

Selecting the Language

Display (example):

- Press »Config. >>« key repeatedly, until »Configuration 3/4« appears.
- Turn dial knob to select item »Language«.
Press dial knob to activate.

The following languages can be selected:

- German – Japanese
- English – Russian
- US English – Greek
- French – Rumanian
- Italian
- Spanish
- Portuguese
- Chinese

- Turn dial knob to select language.
Press dial knob to confirm.

●

NOTE: The newly selected language goes into effect immediately.

CMV Assist	
Paw	0 15 30 45 60 cmH ₂ O
Language	US-English
Baudrate	19200
dd.mm.yy	24 10 00
Parity	no
h:m	16 : 20
Stopbits	1
Configuration 3 / 4 next page "Config. >>"	

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Setting Date and Time

Required when using the MEDIBUS communications interface

- Press »Config. >>« key repeatedly until »Configuration 3/4« appears.
- Turn dial knob to select »dd.mm.yy« field.
Press dial knob to activate.
- Turn dial knob to set the day (dd),
Press dial knob to confirm.
- Set month (mm), year (yy), hour (h), and minutes (m)
in the same fashion.

CMV Assist	
Paw	0 15 30 45 60 cmH ₂ O
Language	US-English
Baudrate	19200
dd.mm.yy	24 10 00
Parity	no
h:m	16 : 21
Stopbits	1
Configuration 3 / 4 next page "Config. >>"	

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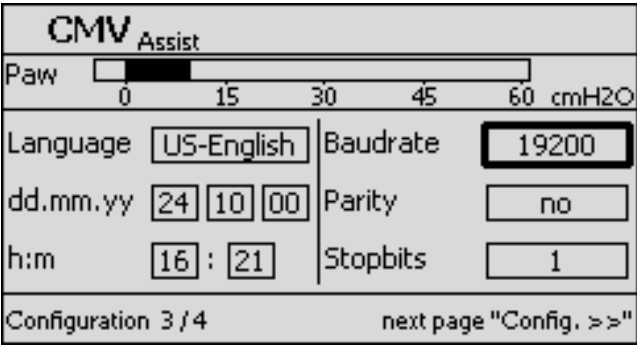
Configuration

Configuring the MEDIBUS Protocol
Displaying Ventilator Data

Configuring the MEDIBUS* Protocol

The following parameters can be set:

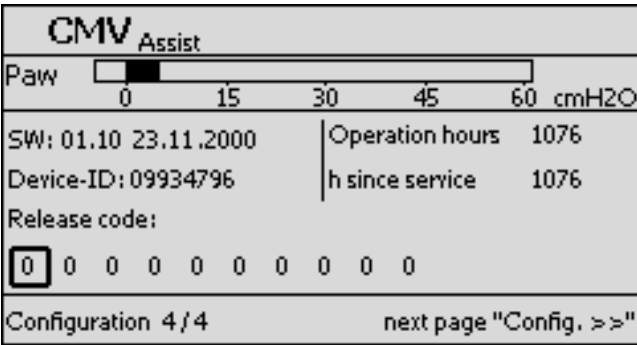
- Baud rate
 - Parity check bits
 - Number of stop bits
- Press »Config. ▢▢« key repeatedly until »Configuration 3/4« appears.
 - Turn dial knob to select field for the corresponding interface parameters, e.g. select baudrate. Press dial knob to release for setting.
 - Turn dial knob to set value. Press dial knob to confirm.



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Displaying Ventilator Data

- Press »Config. ▢▢« key repeatedly until »Configuration 4/4« appears.
- Savina displays:
- **SW-Version**
Software version of the ventilator
 - **Device-ID**
device-specific identification number of the ventilator
 - **Operation hours**
the total number of hours the device has been operating
 - **h since service**
the number of operating hours since the last preventive maintenance by factory trained and authorized technicians.
 - **Release code:**
Number code for releasing available options.



10637222

Return to main page

- Press »Waveforms ▴▴« key until the main page appears, showing a waveform.

* MEDIBUS
Dräger communications protocol for medical devices

Care

Dismantling Components 86

Disinfecting / Cleaning / Sterilizing 89

Disinfecting / Cleaning / Sterilizing Schedule for the
Savina Intensive Care Ventilator 91

Re-assembly 91

Care

- Clean and prepare the ventilator after each patient.

WARNING !

Always use ventilator that has been cleaned and disinfected and has been successfully tested to be ready for operation.

- Always observe accepted hospital hygiene protocols regarding the frequency of patient circuit and expiratory valve changes.

Recommendation:

- Change patient circuit system and expiratory valve as needed. Keep replacement systems ready.

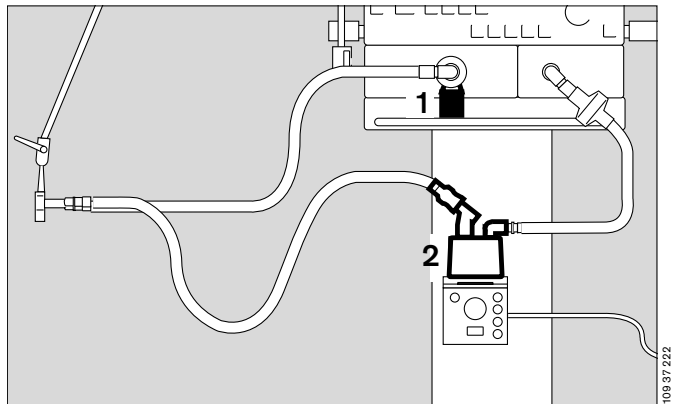
WARNING !

Always follow accepted hospital procedures for handling equipment contaminated with body fluids.

Dismantling Components

- Switch off both ventilator and humidifier, and remove their power plugs.

- 1 Empty water trap on the expiratory valve.
- 2 Empty water container of the humidifier.

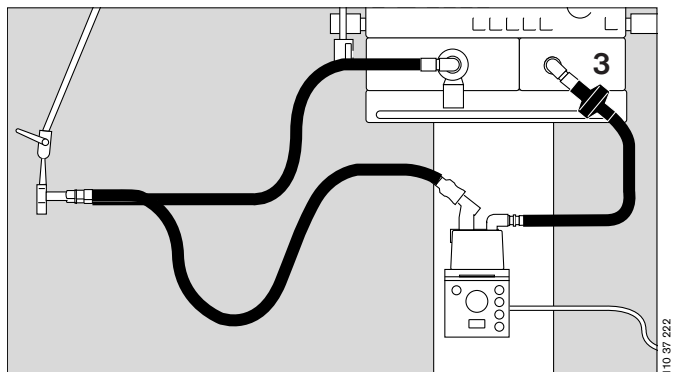


Patient circuit

- Remove patient circuit from ventilator ports.

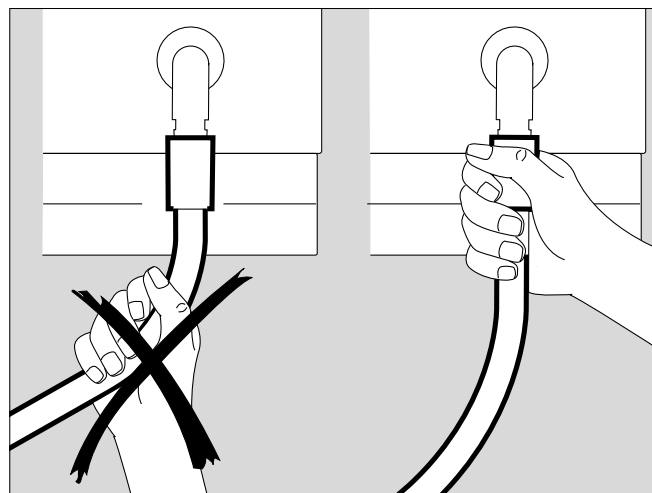
For a Draeger reusable patient circuit:

- Remove water traps from the circuit. Remove collecting jars from water traps and the expiratory valve.
 - Prepare patient circuit, water traps, and associated collecting jars, as well as the the patient wye, for disinfection and cleaning by autoclaving.
- 3 Remove bacteria filter and proess in accordance with its respective instructions for use

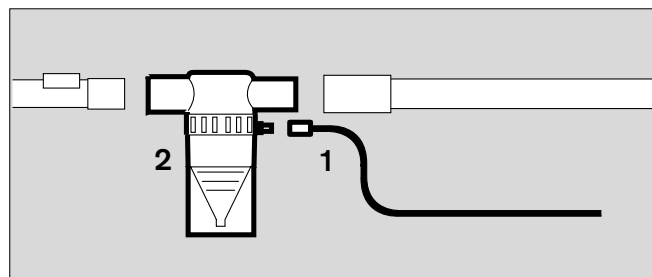


CAUTION !

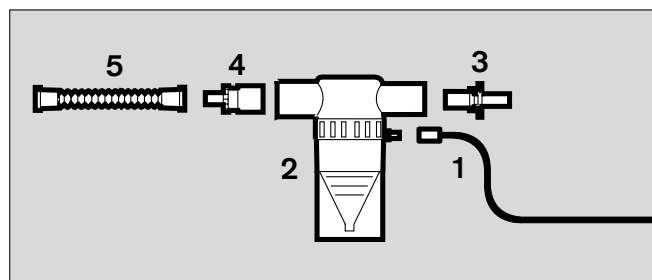
When removing a reusable patient circuit, always grasp hoses by their sleeve, never by the hose itself, to avoid possibly tearing the hose at the sleeve or ripping it out of the sleeve.

**Nebulizer (available option)**

- 1 Remove nebulizer hose from the nebulizer and from the nebulizer port on the ventilator.
- 2 Detach nebulizer from the patient circuit (adult patient circuit), or



- 2 remove nebulizer from the infant patient circuit.
- 3 Pull catheter connector (tapered ISO connector $\varnothing 15/ \varnothing 11$) from the nebulizer input.
- 4 Pull adapter (tapered ISO connector $\varnothing 22/ \varnothing 11$) from the nebulizer output.
- 5 Pull corrugated patient circuit segment from the connector.



- Dismantle and process nebulizer in accordance with its accompanying instructions for use.

Flow sensor

- 1 Push flow sensor to the left as far as it will go and
- 2 pull out.

CAUTION !

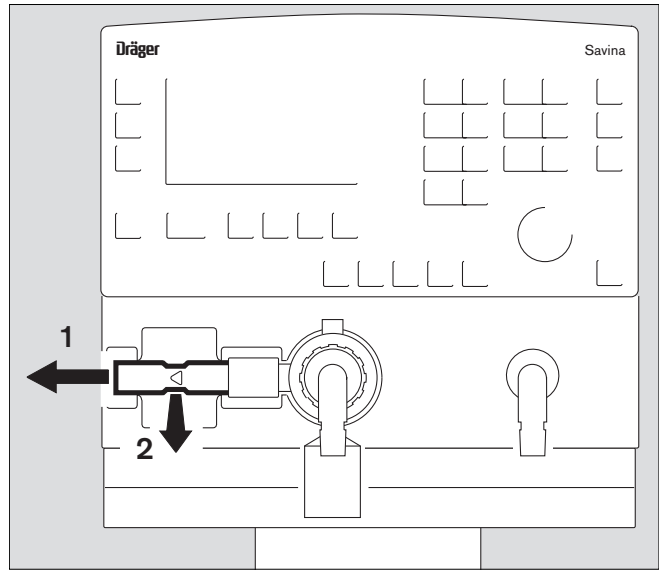
Flow sensor is not compatible with parts washer equipment and may not be autoclaved or steam-sterilized. It is not temperature stable and would be destroyed.

- Disinfect flow sensor for about 1 hour in a 70% ethanol solution.

WARNING !

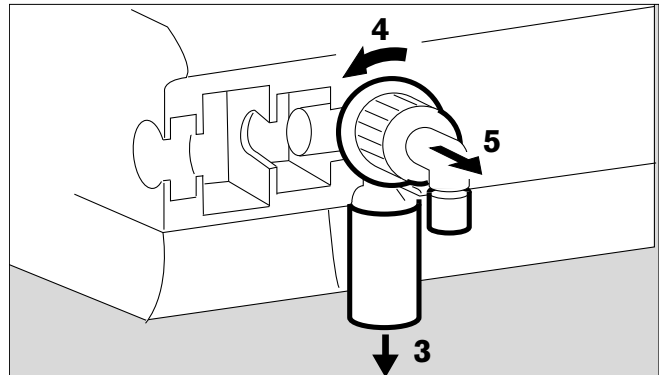
Vent flow sensor after disinfection with ethanol for at least 30 minutes or rinse with sterile water. Otherwise, residual ethanol vapors might ignite and destroy the sensor during calibration.

NOTE: The flow sensor may be reused as long as it can be calibrated successfully.



Expiratory valve

- 3 Remove collecting jar from water trap.
- 4 Turn knurled bushing to the left and
- 5 remove expiratory valve.



- 6 Remove diaphragm.
- 7 Remove rubber bushing.

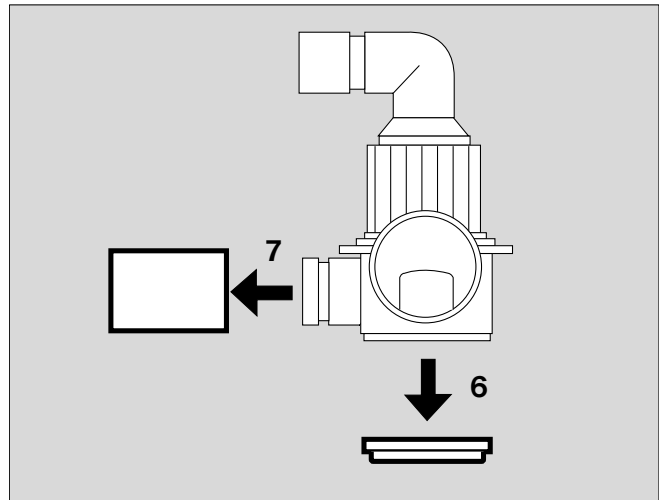
CAUTION !

Do not disassemble expiratory valve beyond removing diaphragm!

NOTE: The expiratory valve together with its diaphragm, rubber bushing and the removed collecting jar of the water trap may be disinfected and cleaned by autoclaving or sterilizing.

Breathing gas humidifier

- Disassemble and prepare for disinfection/sterilization according to its Operating Instructions.



Disinfecting / Cleaning / Sterilizing

CAUTION !

Certain components of the ventilator consist of materials that are sensitive to certain organic solvents sometimes used for cleaning and disinfecting (e.g., alkylamines, phenols, halogen releasing compounds, oxygen releasing compounds, strong organic acids, etc.). Exposure to such substances may cause damage that is not always immediately recognized.

To prevent any damage, we recommend that only detergents and disinfectants are used that are compatible with the device, e.g. surface disinfectants on the basis of aldehydes or quarternary ammonium compounds for disinfection. Ensure that all disinfectants are registered with the U.S. Environmental Protection Agency for use as intended. Always follow the instruction labels specifically with respect to prescribed concentrations and the necessary exposure times. Disinfectants often contain – besides their main active agents – additives that can also damage materials. If in doubt, ask the supplier/manufacturer of the disinfectant/cleaning agent.

CAUTION !

Sterilization of parts in ethylene oxide (EtO) may lead to a patient health risk:
Patients may become exposed to EtO that may have diffused into components.

WARNING !

Follow all accepted hospital procedures for disinfecting parts contaminated by body fluids (protective clothing, eyewear, etc.).

- Savina ventilator with mobile stand,
 - hinged circuit support arm,
 - gas supply hoses
 - Wipe disinfect with a disinfectant based on the suggested active ingredients.
- Always comply with manufacturer's instructions.

Care

Disinfecting / Cleaning / Sterilizing

- Reusable patient circuit,
- reusable patient wye,
- water traps and collecting jars
- expiratory valve body
- expiratory valve diaphragm
- expiratory valve collecting jar
- May be disinfected in a moisture saturated environment at 93 °C(200 °F) for 10 minutes **Use detergent only.**

- Reusable patient circuit,
 - reusable patient wye,
 - water traps and collecting jars
 - expiratory valve body
 - expiratory valve diaphragm
 - expiratory valve collecting jar
- are thermally stable and may be steam-sterilized at 134°C (273 °F).

- **Nebulizer**
- Process in accordance with its accompanying instructions for use.

- **Bacteria filter**
- Process in accordance with its accompanying instructions for use.

Disinfecting / Cleaning / Sterilizing Schedule for the Savina Intensive Care Ventilator

Applicable for use with non-infectious patients.

For infectious patients, all parts that conduct breathing gas must be additionally sterilized after disinfecting and cleaning.

The breathing gas conducting parts listed here can be steam-sterilized at 134 °C. See "Sterilizing" column.

This table serves as a guideline only.

Always follow accepted hospital procedures and protocols for cleaning and disinfecting

Part	How often	How			
		Disinfecting and cleaning			Sterilizing
		Autoclaving at 93 °C, 10 minutes	Wiping ¹	Bath immersion	Steam 134 °C, 10 minutes
Savina ventilator	after each patient	no	outside	no	no
mobile stand circuit support arm gas supply hoses	after each patient	no	outside	no	no
patient circuit, patient wye, water traps and collecting jars	after each patient as needed	yes	no	possible	yes
expiratory valve	after each patient as needed	yes	no	possible	yes
flow sensor	as needed	no ²	outside	possible ²	no
temperature sensor	as needed	no	yes	no	yes

1. with an approved wipe disinfectant based on the recommended active ingredients, see page 89

2. Special treatment, bath disinfect in 70% ethanol, see page 88

Re-assembly

Please refer to "Assembly of Components" on page 30 in chapter "Preparation".

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Maintenance

Maintenance Intervals	95
User Replaceable Parts	96
Using an External Battery	98
Disposal of Batteries and O2 Sensors	99
Considerations for Extended Storage	99
Correct Disposal of Ventilator	99

Maintenance

CAUTION ! Maintenance

The device must be inspected and serviced at regular intervals. A record must be kept on this preventive maintenance. We recommend obtaining a service contract with DrägerService through your vendor.
For repairs we recommend that you contact DrägerService.

WARNING !

To avoid any risk of infection, clean and disinfect ventilator and accessories before any maintenance according to established hospital procedures - this applies also when returning ventilators or parts for repair.

WARNING !

Never operate the ventilator if it has suffered physical damage or does not seem to operate properly.
We recommend that you contact DrägerService for maintenance service for the Savina Ventilator.

WARNING !

Treatment of batteries and O₂-sensor capsules:
Do not throw into fire! Risk of explosion.
Do not force open! Danger of bodily injury.
Follow all local, state, and federal regulations with respect to environmental protection when disposing of batteries and O₂-sensor capsules.

WARNING !

Both breathing and cooling air are drawn in through the filter cover.
Do not block air intake, do not place ventilator immediately against a wall – risk of overheating the ventilator.

WARNING !

When servicing the ventilator, always use replacement parts that are qualified to Dräger standards.
Dräger cannot warrant or endorse the safe performance of third party replacement parts for use with the Savina ventilator

CAUTION !

Never operate the ventilator without a microfilter at the air intake. The inspiratory side of the ventilator and patient circuit would become dirty.

Maintenance Intervals

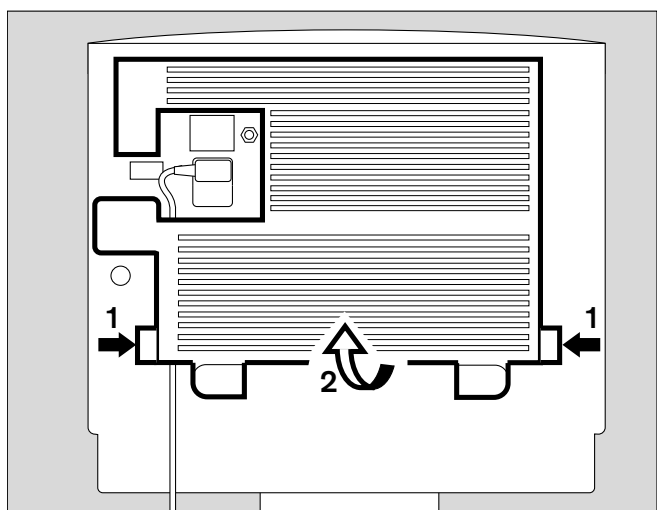
O ₂ sensors	<p>Replace when the following message is displayed: !!! O₂ measurement inop. or when calibration is no longer possible. For disposal of spent sensor capsules, see page 99.</p>
Microfilter	<p>Replace after 1 year, see page 96. Disposal with normal domestic waste.</p>
Dust filter set	<p>Replace after 1 year, see page 97. Disposal with normal domestic waste.</p>
Blower unit	<p>To be replaced after 20,000 hours of operation or after 8 years (whichever comes first) by DrägerService or factory trained and authorized technical service personnel.</p>
Lead-gel battery	<p>To be replaced after 2 years by DrägerService or factory trained and authorized technical service personnel. Lead-gel batteries should be disposed of as special waste, see page 99.</p>
Filter in O ₂ inlet	<p>To be replaced 2 years by DrägerService or factory trained and authorized technical service personnel.</p>
Real-time clock module	<p>To be replaced every 6 years by DrägerService or factory trained and authorized technical service personnel.</p>
Pressure reducer	<p>To be replaced every 6 years by DrägerService.</p>
Equipment inspection and service	<p>For the first time after 2 years or after 6,000 hours of operation – whichever comes first; thereafter annually or after 6,000 hours of operation – whichever comes first</p> <p>Equipment inspection and service every six months is recommended to ensure maximum availability.</p> <p>To be performed by DrägerService or factory trained and authorized technical service personnel</p>

User Replaceable Parts

Replacing the microfilter

- Filter should be replaced every year.

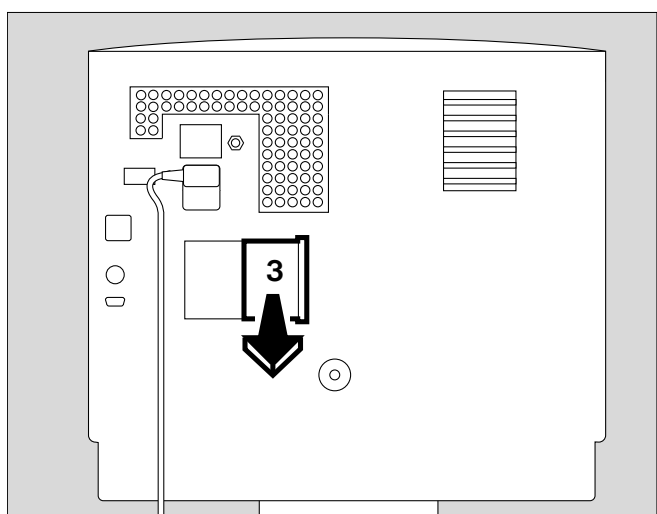
- 1 Hold down both latches,
- 2 Lift filter cover and remove.



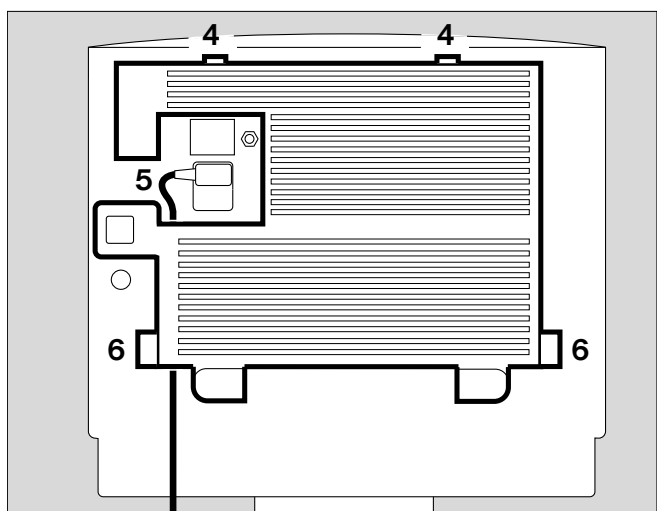
- 3 Remove used microfilter from its housing.
- Slide new microfilter into housing as far as it will go.
 - Dispose of used microfilter together with domestic waste.

CAUTION !

Never operate the ventilator without a microfilter. The inspiratory side of the ventilator and patient circuit would become dirty.



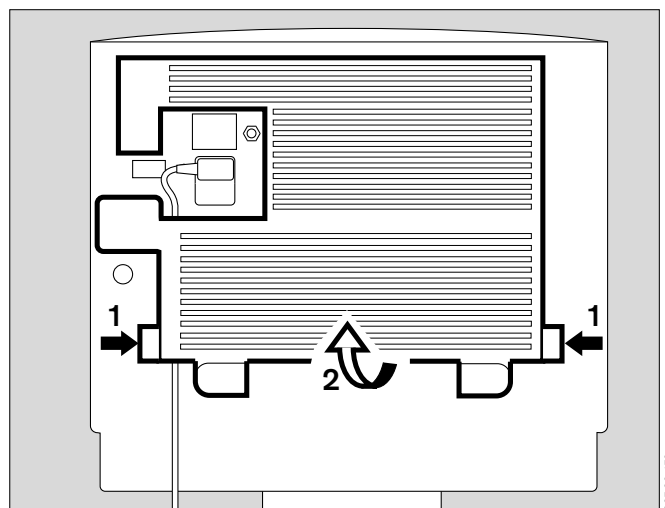
- 4 Insert filter cover with its two lugs into rear panel.
- 5 Position power cable under filter cover.
- 6 Push latches into housing until they engage.



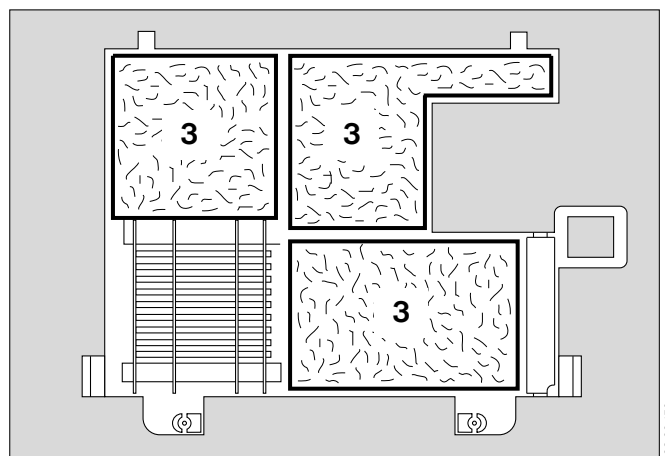
Replacing the dust filter set

- Inspect for soiling every 4 weeks, clean or replace as necessary.

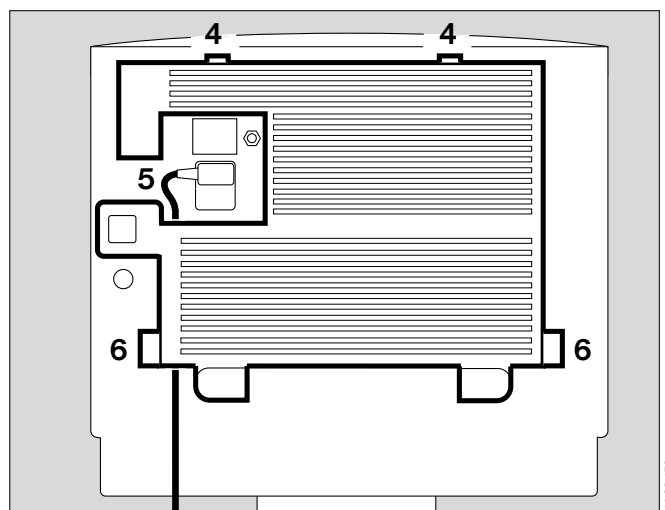
- 1 Hold down both latches.
- 2 Lift filter cover and remove.



- 3 Remove used dust filters from filter cover.
- Install new dust filters.
- Dispose of used dust filters with domestic waste.



- 4 Slide the two lugs of the filter cover into the rear panel.
- 5 Place AC power cable under the filter cover.
- 6 Push latches into their openings until they engage.

**WARNING !**

Both breathing and cooling air are drawn in through the filter cover.

Do not block air intake, do not place ventilator immediately against a wall – risk of overheating the ventilator

Replacing the O₂ Sensors

- If the following message appears:
!!! O₂ measurement failure
Replace O₂ sensor 1
or
!!! O₂ measurement failure
Replace O₂ sensor 2
- If calibration is no longer possible.

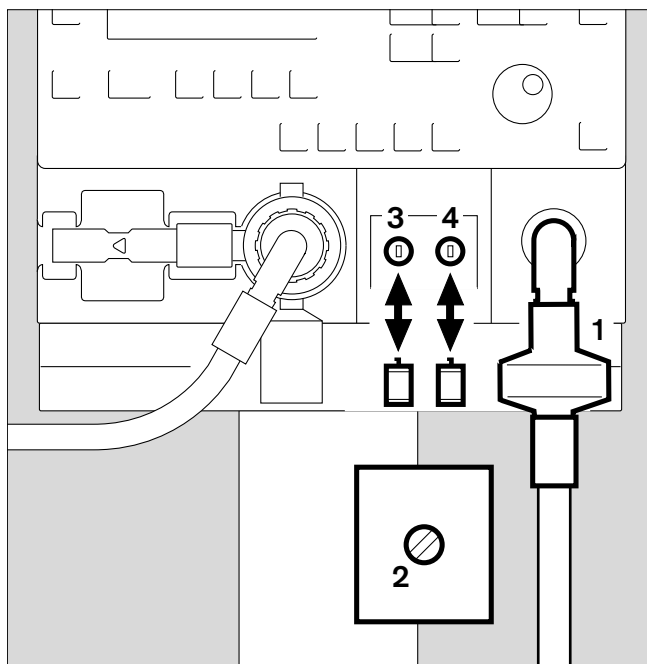
- 1 Swivel inspiratory port downwards
- 2 Undo screw (use coin) and remove cover plate,
- 3/4 Remove used O₂ sensor from housing
- 3/4 Slide new O₂ sensor into the respective housing for "Sensor 1" or "Sensor 2". Turn using light pressure until O₂ sensor slides further into the housing.
- 2 Screw cover plate back into place.

Sensor 1
is automatically calibrated after installation.

Sensor 2:

- Wait for at least 20 minutes of warm-up, then
- calibrate manually, see page 80.

NOTE: The internal battery supplies current to the two O₂ sensors even when Savina is switched off. This enables Savina to measure valid O₂ values as soon as it is switched on. If the internal battery is discharged, Savina does not supply any O₂ values for the first 20 minutes after switching on. Blending of O₂ is performed at reduced accuracy during this time.



Using an External Battery

Either 12 V or 24 V external batteries may be connected. It is recommended to use 24 V batteries (2 x 12 V batteries connected in series) with a minimum capacity of 15 Ah each. The operating efficiency of the DC/DC converter and the resulting operating hours are significantly better for such an arrangement than for 12 V batteries of comparable energy capacity.

Disposal of Batteries and O2 Sensors

WARNING !

Treatment of batteries and O2-sensor capsules:
Do not throw into fire! Risk of explosion.
Do not force open! Danger of bodily injury.
Follow all local, state, and federal regulations with respect to environmental protection when disposing of batteries and O2-sensor capsules.

Internal Batteries

The permanent batteries installed in the Savina ventilator contain harmful substances (lead and sulphuric acid). They should be removed and disposed of by DrägerService or factory trained and authorized technical service personnel.

O2 sensors

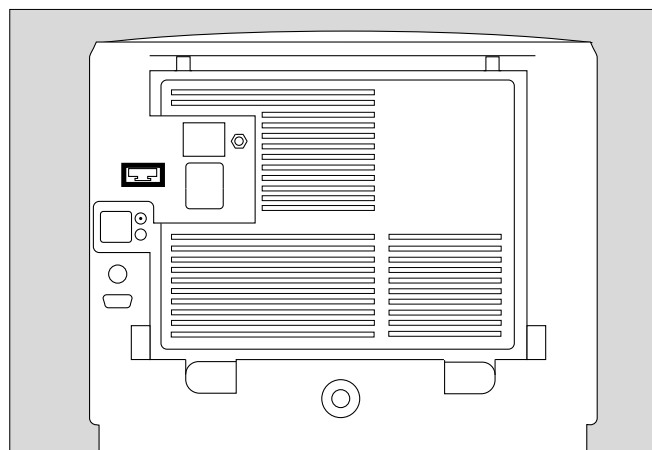
- Dispose of O2 sensors in the same way as batteries (contain sulphuric acid).

Information may be obtained from local environmental and public health authorities or from approved waste disposal companies.

Considerations for Extended Storage

If Savina is stored for more than a month without power:

- Remove fuse for internal battery. This will prevent an undesirable deep discharge of the internal battery, which otherwise would continue to supply current to the O2 sensors.



Correct Disposal of Ventilator

- at the end of its useful life.
- Contact a licensed waste disposal company for appropriate disposal of Savina.
 Follow all local, state, and federal regulations with respect to environmental protection when disposing of the ventilator.

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Troubleshooting

Troubleshooting 104

Troubleshooting

Alarm messages in the alarm display field are displayed in hierarchical order.
For example, if two faults are detected simultaneously, the more urgent of the two is displayed.

The priority level of the alarm messages (see page 66 for definitions) is identified by exclamation marks:

- Warning = !!! Message with top priority
- Caution = !! Message with medium priority
- Advisory = ! Message with low priority

In the table below, messages are listed in alphabetical order.
This table is intended to help identifying possible causes of an alarm
and to assist with prompt corrective action.

Message	Cause	Remedy
!!! Airway pressure high	The upper alarm limit for the airway pressure has been exceeded. Patient is "fighting" the ventilator, coughing.	Check patient condition. Check ventilation pattern. Correct alarm limit if necessary.
	Kinked patient circuit	Check patient circuit and tube.
!!! Airway pressure low	Leaking cuff.	Inflate cuff and perform leak test.
	Leak or disconnection.	Check patient circuit for tight connections. Check that the expiratory valve is properly engaged.
!!! Amb. press. meas. failure.	Internal pressure sensor faulty.	Due to ambient pressure measurement failure the actual VT and MV is calculated with an ambient pressure of 1013 mbar which may lead to incorrect values for VT and MV. It is possible to use Savina further on when PAW-high-alarm is set correct and incorrect values for VT and MV are tolerable, evaluation of the patient is required. For adequate ventilation increased volume adjustment may be required. Call DraegerService.
!!! Apnea	Patient's spontaneous breathing has stopped.	Apply controlled ventilation.
	Flow sensor not calibrated or faulty.	Calibrate flow sensor. Replace if necessary.
	Disconnection	Reconnect

Message	Cause	Remedy
!! Apnea ventilation	Since an apnea was detected, the system has been automatically switched over to mandatory ventilation.	Check ventilation mode. To return to the original ventilation mode: Press »Alarm Reset« key.
! Atmospheric pressure high	The device is being used at too high atmospheric pressure.	Use Savina within the specified atmospheric pressure range, see Technical data, page 120
	One of the pressure sensors is defective.	Due to ambient pressure measurement failure the actual VT and MV is calculated with an ambient pressure of 1013 mbar which may lead to incorrect values for VT and MV. It is possible to use Savina furtheron when PAW-high-alarm is set correct and incorrect values for VT and MV are tolerable, evaluation of the patient is required. For adequate ventilation increased volume adjustment may be required. Call DraegerService.
! Atmospheric pressure low	The device is being used at too low atmospheric pressure.	Use Savina within the specified atmospheric pressure range, see Technical data, page 120
	One of the pressure sensors is defective.	Due to ambient pressure measurement failure the actual VT and MV is calculated with an ambient pressure of 1013 mbar which may lead to incorrect values for VT and MV. It is possible to use Savina furtheron when PAW-high-alarm is set correct and incorrect values for VT and MV are tolerable, evaluation of the patient is required. For adequate ventilation increased volume adjustment may be required. Call DraegerService.
!!! Battery not charging	Battery discharged.	With AC-power connected Savina may continue ventilation. Call DraegerService.
!!! Breathing gas temp. high	Breathing gas temperature above 40 °C.	Turn humidifier off. Use longer inspiratory patient circuit..
!! Check settings	Due to an internal data loss, Savina operates with factory default settings.	Check settings and adjust.

Message	Cause	Remedy
!!! Device failure XX.YYYY	Ventilator fault.	If the warning is resettable by pressing the key »Alarm Reset« Savina can be used for further ventilation. If Savina is not resettable by pressing the »Alarm Reset« key, remove from service and start ventilation using an independent ventilation device as soon as possible, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!! Device temp. too high	Temperature inside the ventilator has become too high.	Check condition of the dust filter and replace if necessary, page 97
!!! Exp. valve failure	Expiratory valve not properly engaged.	Install expiration valve correctly.
	Faulty flow sensor.	Replace flow sensor.
	Faulty expiratory valve.	Replace expiratory valve.
! Ext. DC supply active	Ventilator operating from external battery.	Note capacity of external power source.
!!! Fan failure	Fan failure.	The fan is needed for cooling and to avoid fire risk in case of O ₂ -leakage; in case of fan failure remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!!! FiO ₂ high	Faulty blender.	Use external O ₂ -monitoring. Switch off internal O ₂ -monitoring (see page 81 in Operating Instructions) in order to suppress alarms. Continue ventilation with Savina. Call DraegerService.
!!! FiO ₂ low	Diluted O ₂ source.	If this alarm occurs (e. g. after manual calibration with a reliable independent O ₂ source), make sure that your O ₂ source in use contains 100 % O ₂ .
	Faulty blender.	Use external O ₂ -monitoring. Switch off internal O ₂ -monitoring (see page 81 in Operating Instructions) in order to suppress alarms. Continue ventilation with Savina. Call DraegerService.

Message	Cause	Remedy
!!! Flow measurement failure	Water in flow sensor	Dry flow sensor.
	Faulty flow sensor.	Replace flow sensor.
	Faulty flow measurement.	Use external flow-monitoring. Switch off internal flow-monitoring (see page 81 in Operating Instructions) in order to suppress alarms. Continue ventilation with Savina. Call DraegerService.
! Flow monitoring off	Flow monitoring is switched off.	Switch flow monitoring back on, see page 81, or provide adequate external monitoring immediately.
!!! Flow sensor?	Flow sensor not fully inserted in rubber grommet of expiratory valve.	Insert flow sensor correctly.
!!! High frequency	Patient is breathing at a high spontaneous frequency (tachypnea). Monitored (overall) breath rate is too high	Check patient condition. Check ventilation pattern. Correct alarm limit if necessary.
!!! Insp/Exp cycle failure	Ventilator does not deliver breathing gas.	Set a CMV rate of at least 4/min.
!!! Insp/Exp cycle failure (cont'd)	Alarm delay $T_{Apnea} \sqrt{f}$ is set to a value smaller than the time for a breath cycle ($T_{Apnea} \sqrt{f} < 1/\text{rate}$).	Extend alarm delay $T_{Apnea} \sqrt{f}$.
	Disconnection	Reconnect
! Insp. hold interrupted	The »Insp. hold« key was held down longer than 15 seconds.	Release »Insp. hold« key.
!!! Int. battery failed	Internal battery has failed.	With AC-power connected Savina may continue ventilation. Call DraegerService.
!!! Int. batt. almost discharged	Time for operation from internal battery has almost expired, AC line power or external DC power are not connected.	Immediately connect to AC line power, external battery, or an on-board DC system.
! Int. batt. almost discharged	AC line power connected; internal battery almost discharged.	Do not switch Savina over to operate from its internal battery.
!! Int. battery activated	Savina is being supplied via the internal battery because no AC, external battery, or on-board DC supply is available. The typical operating time when drawing from the internal battery is 60 minutes.	Restore mains power or supply from a charged external battery or an on-board DC system within 60 minutes. This alarm can be acknowledged with the »Alarm Reset« key. It will then appear as an advisory message (!).

Message	Cause	Remedy
! Int. battery activated	Savina is being supplied via the internal battery because no AC, external battery, or on-board DC supply is available. The typical operating time when drawing from the internal battery is 60 minutes.	Restore AC line power or supply from a charged external battery or an on-board DC system within 60 minutes.
!! Int. battery low	Savina is being supplied via the internal battery because no AC, external battery, or on-board DC supply is available. There are only a few minutes of operating time left.	Restore AC line power or supply from a charged external battery or an on-board DC system immediately.
! Int. battery low	AC line power connected; internal battery almost discharged.	Do not switch over Savina to operate from its internal battery.
!! Key xx failed	xx key (e.g. »Alarm Silence«) can no longer be pressed.	Remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!! Key xx overused	Keys pressed very frequently within a short time (e.g. »Alarm Silence« key).	Acknowledge message by pressing the »Alarm Reset« key. If this message appears again: Remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!! Main switch overused	Savina has detected very frequent operation of the switch within a short time.	Acknowledge message by pressing the »Alarm Reset« key. If message appears again: Ventilation may be continued (if Savina cannot be switched off: Switch off main switch; then press key »Stand by« to shut down Savina). Call DraegerService.
! MEDIBUS COM. failure.	The connector of the MEDIBUS cable has been unplugged during operation.	Reconnect connector and secure against disconnection with the two screws.
	Faulty MEDIBUS cable.	Use a new MEDIBUS cable.
	Faulty interface card.	Ventilation may be continued when data transfer to external monitor via MEDIBUS does not work. Call DraegerService.
!! Microfilter blocked	Microfilter clogged.	Change microfilter, see page 96.

Message	Cause	Remedy
!!! Microfilter missing	Microfilter missing or not correctly installed.	Install microfilter, see page 96.
!!! MV high	Minute volume has exceeded the upper alarm limit.	Check patient condition. Check ventilation pattern. Correct alarm limit if necessary.
	Flow sensor faulty.	Replace flow sensor.
	Water in flow sensor.	Drain water trap, dry flow sensor.
	Ventilator fault.	Remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!!! MV low	Minute volume has fallen below the lower alarm limit.	Check patient condition. Check ventilation pattern. Correct alarm limit if necessary.
	Leak in circuit system.	Ensure that the circuit system is leakproof.
	Faulty flow sensor.	Replace flow sensor.
	Ventilator fault.	Remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
! Nebulizer on	Nebulizer for medicated aerosols is switched on.	
!!! No int. battery	Internal battery, missing, faulty, or not connected, or fuse has failed.	This alarm can be acknowledged with the »Alarm Reset« key. It will then appear as an advisory message (!). With AC power connected Savina may continue ventilation. Call DraegerService.
! No int. battery	Internal battery, missing, faulty, or not connected, or fuse has failed.	With AC power connected Savina may continue ventilation. Call DraegerService.

Message	Cause	Remedy
!!! O2 measurement failure	O2 sensor provides invalid measured values.	Calibrate O2 sensor, see page 76. Replace if necessary.
	O2 sensor depleted or not installed.	Install new O2 sensor, see page 98. Calibrate, see page 76.
	Faulty O2 measurement.	Use external O2-monitoring. Switch off internal O2-monitoring (see page 81 in Operating Instructions) in order to suppress alarms. Continue ventilation with Savina. Call DraegerService.
!! O2 monitoring off	Upon switching on, Savina detected that O2 monitoring is switched off.	Reactivate O2 monitoring, see page 81 or immediately provide adequate external monitoring. This alarm can be acknowledged with the »Alarm Reset« key. It will then appear as an advisory message (!).
! O2 monitoring off	O2 monitoring switched off. Switched-off state has been confirmed.	Switch O2 monitoring back on, see page 81 or immediately provide adequate external monitoring.
!!! O2 supply down	O2 supply pressure too low.	Ensure pressure is greater than 39 psi (2.7 bar).
! O2 supply down	O2 supply pressure too low. O2 supply pressure is not required when FiO2 is set to 21 %.	Ensure pressure is greater than 39 psi (2.7 bar).
!! O2 supply pressure high	O2 supply pressure too high.	Make sure pressure is less than 87 psi (6 bar).
! O2 supply pressure high	O2 supply pressure too high. O2 supply pressure is not required when FiO2 = 21 % of vol.	Make sure pressure is less than 87 psi (6 bar).
!!! PEEP high	Expiratory limb of patient circuit incorrectly positioned.	Check circuit system and expiratory valve.
	Increased expiratory resistance.	Check bacteria filter. Replace if necessary.
!!! PEEP failure	Set PEEP is not reached.	Check system for leaks. Ventilation may be continued but the set PEEP may not be reached. Patient assesment is required. Call DraegerService.

Message	Cause	Remedy
!!! Pressure meas. failure	Fluid in expiratory valve.	Replace expiratory valve, then disinfect/clean and dry, see page 89.
	Pressure measurement fault.	Remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!!! PS > 4 s	The pressure support cycle has been switched off 3 times because the time limit was exceeded.	Check circuit system for leaks.
! PS > 4 s	The pressure support cycle has been switched off because the time limit was exceeded.	Check circuit system for leaks.
!! Rotary knob failed	Dial knob cannot be turned or pressed.	Remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!! Rotay knob overused	Knob has been pressed frequently within a brief period of time.	Confirm with »Alarm Reset« key In case this message appears repeatedly: Remove Savina from service and start ventilation using an independent ventilation device without delay, if necessary with PEEP and / or increased inspiratory O ₂ concentration. Call DraegerService.
!!! Standby activated	Savina has been switched to standby.	Confirm standby mode by pressing »Alarm Reset«.
!!! Temperature high	Breathing gas temperature in Savina is above 40 °C	Ensure lower ambient temperature. for patient protection, turn heated humidifier off.
! Temperature high	While still reaching peak pressure, the ventilator is not reaching peak flow values due to high ambient temperature (35 to 40 °C).	Lower ambient temperature.
!!! Temperature meas. failure	Faulty temperature sensor.	Install new temperature sensor.
!!! Temperature sensor ?	Temperature sensor probe has been disconnected during operation.	Reconnect probe.
	Broken sensor cable.	Install new temperature sensor.

Message	Cause	Remedy
!!! Tidal volume high	The upper alarm limit of the applied inspiratory tidal volume VT has been exceeded during three consecutive ventilator breaths.	Check patient condition. Check ventilation pattern. Correct alarm limits, if necessary.
	Leak or disconnection.	Check that all connections of the patient circuit system are leakproof.
! Tidal volume high	The upper alarm limit of the applied inspiratory tidal volume VT has been exceeded	Check patient condition. Check ventilation pattern. Correct alarm limits, if necessary.
	Leak or disconnection.	Check that all connections of the patient circuit system are leakproof.
!! Tidal volume low	After fourth ventilator breath: Because of pressure and time limitations, the set tidal volume VT is not being applied.	Extend inspiration time »Tinsp.« Raise FlowAcc. Raise pressure limitation Paw, using »Pinsp« key. This alarm can be acknowledged with the »Alarm reset« key. It will then appear as an advisory message (!).
	After fourth ventilator breath in AutoFlow: Because of pressure and time limitations the set tidal volume VT is not being applied.	Extend inspiration time »Tinsp.« Raise FlowAcc. Raise upper pressure limit. This alarm can be acknowledged with the »Alarm reset« key. It will then appear as an advisory message (!).
! Tidal volume low	After second ventilator breath: Because of pressure and time limitations, the set tidal volume VT is not being applied.	Extend inspiration time »Tinsp.« Raise »FlowAcc«. Raise pressure limitation Paw, using »Pinsp« key.
	After second ventilator breath in AutoFlow: Because of pressure and time limitations the set tidal volume VT is not being applied.	Extend inspiration time »Tinsp.« Raise »FlowAcc«. Raise upper pressure limit Paw \sqrt{x}

What's What

Control Unit 112

Front Connection Block 113

Rear Panel 114

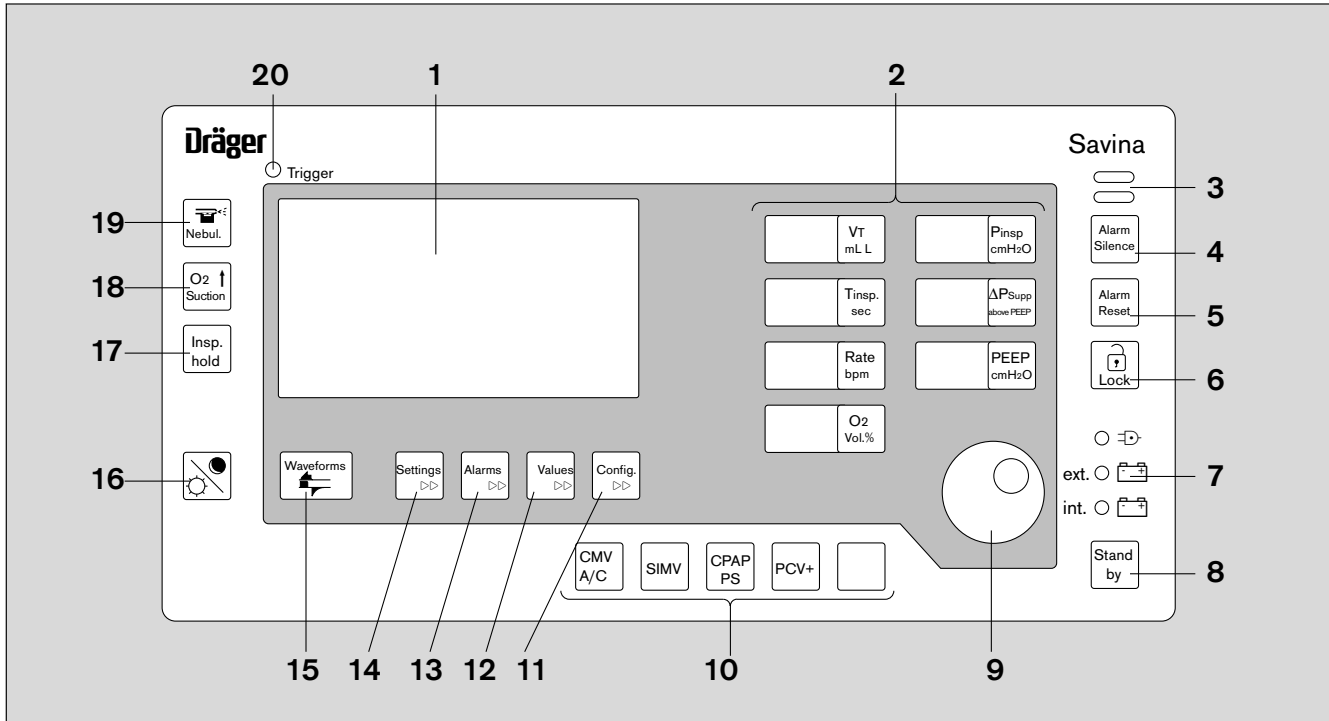
Labels 115

Abbreviations 116

Symbols 118

What's What

Control Unit



- 1 Screen for displaying application-specific screen pages.
- 2 Parameter keys for setting ventilation parameters and displaying their settings.
- 3 Red and yellow lamps for alarms and advisory messages.
- 4 »Alarm Silence« key for suppressing audible alarms for 2 minutes.
- 5 »Alarm Reset« key for acknowledging alarm messages.
- 6 »Lock« key for protecting against unauthorized modification.
- 7 Power supply indicators

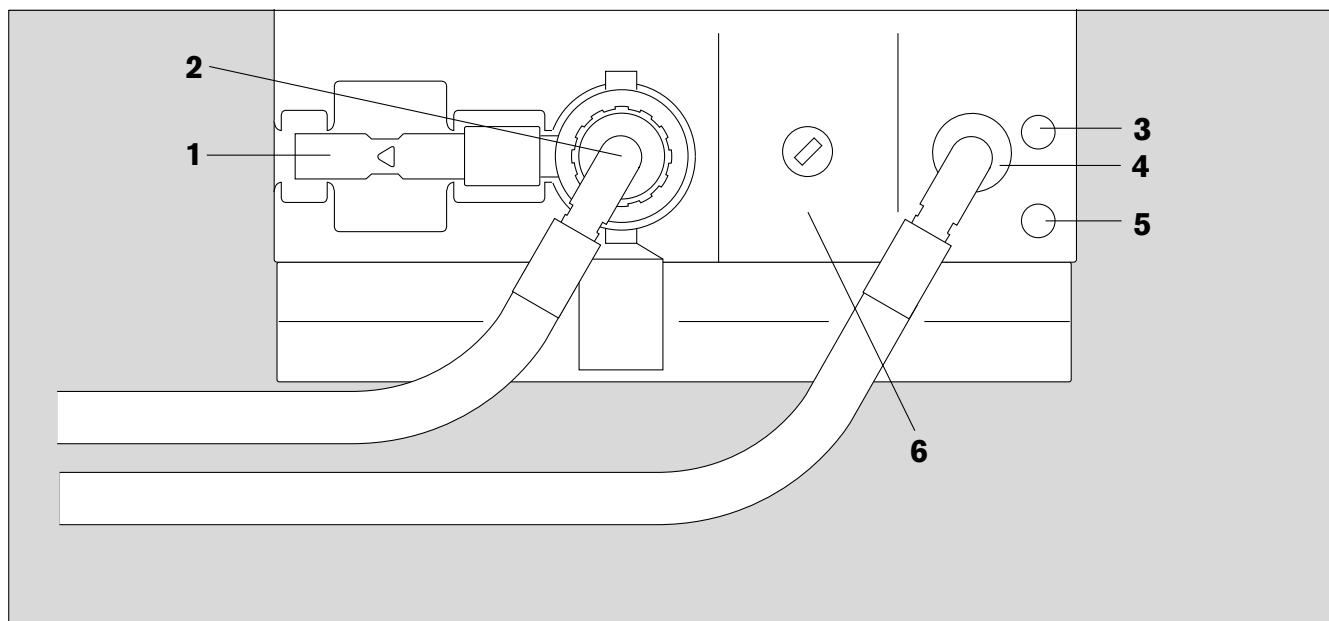
ext. AC line power

ext. External battery or DC on-board network

int. Internal battery

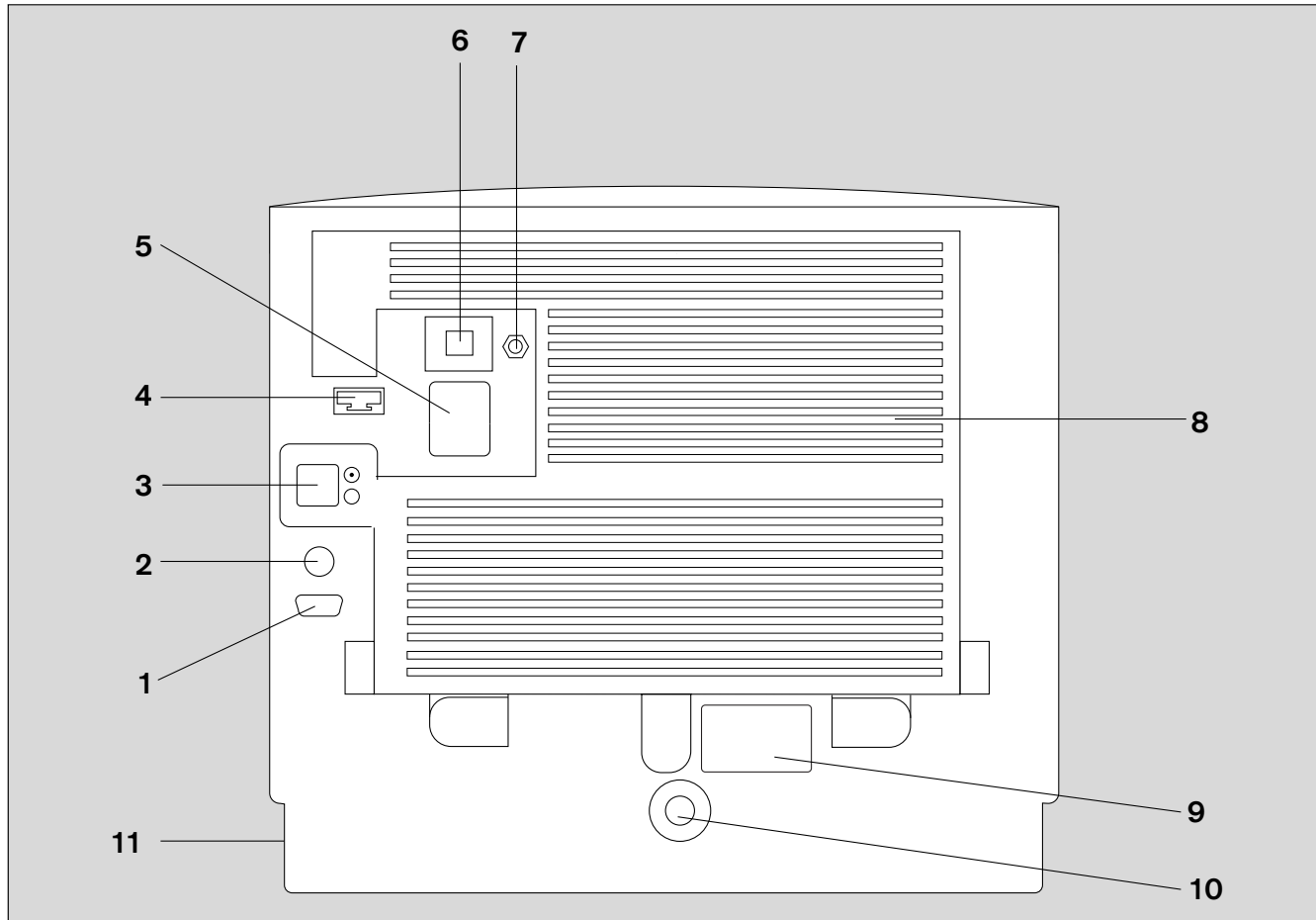
- 8 »Stand by« key for changing between ventilation and standby mode.
- 9 Central "turn and press" rotary dial knob for selecting and confirming settings.
- 10 Keys for ventilation modes **CMV A/C**, **SIMV**, **CPAP/PS**, **PCV+**

- 11 »Config. « key for system settings.
- 12 »Values « key for displaying measured values.
- 13 »Alarms « key for setting and displaying alarm limits.
- 14 »Settings « key for setting other ventilation parameters on screen.
- 15 »Waveforms « key for changing to the main screen page and for switching between waveforms (Flow or Paw).
- 16 » « key for switching the screen brightness between bright / dark.
- 17 »Insp. hold« key for manual inspiration.
- 18 »O2 ↑ Suction« key for pre-/post-oxygenation during bronchial suction
- 19 » Nebul.« key for switching the pneumatic nebulizer for medicated aerosols on / off.
- 20 Trigger indicator.

Front Connection Block

- 1 Flow sensor
- 2 Expiratory valve with expiratory connector port
- 3 Socket for breathing gas temperature sensor plug
- 4 Inspiratory connector port
- 5 Nebulizer gas supply port
- 6 Protective cover for O₂ sensors

Rear Panel



- 1 RS232 serial interface
- 2 Nurse call socket (optional)
- 3 Power switch
- 4 Fuse for internal battery
- 5 AC input receptacle
- 6 DC inlet (external battery or on-board DC system)
- 7 Equipotential bonding connection (grounding pin)
- 8 Filter cover
- 9 Low pressure O2 inlet (optional)
- 10 In the side panel:
connection for O2 high pressure supply hose

Please adjust label wording to
match what's on the ventilator

Labels

1 Main WARNING/CAUTION label

<p>DANGER !</p> <p>RISK OF EXPLOSION IF USED IN THE PRESENCE OF FLAMMABLE ANESTHETICS</p> <p>WARNING !</p> <p>DISCONNECT SUPPLY BEFORE SERVICING REPAIRS ON THIS EQUIPMENT TO BE PERFORMED ONLY BY DraegerService OR BY AUTHORIZED REPRESENTATIVES OF DraegerService</p> <p>CAUTION !</p> <p>TO MAINTAIN GROUNDING INTEGRITY, CONNECT ONLY TO A "HOSPITAL GRADE" RECEPTACLE</p> <p>TO REDUCE RISK OF ELECTRIC SHOCK, DO NOT REMOVE COVER</p> <p>FEDERAL (USA) LAW RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN</p>	006 29 171
--	------------

2 Air intake CAUTION label

<p>CAUTION !</p> <p>DO NOT BLOCK AIR INTAKE VENTILATOR MALFUNCTION WILL RESULT</p>

3 ID label, Dräger Medizintechnik GmbH Lübeck

<p>REF _____</p> <p>SN _____</p> <p>[_____ * (Barcode) _____]</p> <p>Made in Germany Dräger Medizintechnik GmbH 23542 Lübeck, Germany</p>

4 WARNING label to assure accurate O₂ calibration





















<p>WARNING !</p> <p>ALWAYS USE A RELIABLE INDEPENDENT O₂ SUPPLY DURING CALIBRATION. IN CASE THE CALIBRATION PROCEDURE IS BASED ON A DILUTED OXYGEN SOURCE, SAVINA MAY DELIVER INACCURATE OXYGEN CONCENTRATIONS WITHOUT FURTHER NOTIFICATION.</p>

Abbreviations

Abbreviation	Definition
A/C	Assist Control , Assisted Mandatory Ventilation
BTPS	Body Temperature, Pressure, Saturated Measured values based on the conditions of the patient's lungs, with body temperature 37 °C, atmospheric pressure, steam-saturated gas
C	Compliance
CMV	Continuous Mandatory Ventilation
CMV _{Assist}	Assisted Continuous Mandatory Ventilation
CPAP	Continuous Positive Airway Pressure Breathing with continuous positive pressure in the airways
CPPV	Continuous Positive Pressure Ventilation
$\Delta P_{\text{supp. above PEEP}}$	Setting for pressure support above PEEP
EN 794-1	European standard for medical ventilation equipment Part 1, "Intensive Care Ventilation"
f	frequency
f _{Apnea}	Frequency setting for apnea ventilation
f _{tot}	Overall breathing frequency (mechanical and spontaneous)
Fail to cycle	Ventilator detects no inspiration
FiO ₂	Inspiratory O ₂ concentration
FlowAcc	Flow acceleration
Int. PEEP	Intermittent Positive End-Expiratory Pressure = Sigh
IPPV	Intermittent Positive Pressure Ventilation
IRV	Inversed Ratio Ventilation Ventilation with inversed inspiration/expiration ratio
I : E	Ratio of Inspiration time to Expiration time
MV	Minute ventilation
MV _{spn}	Spontaneous fraction of minute ventilation
O ₂	Setting for inspiratory oxygen concentration
P _{aw}	Airway pressure
PCV+ (BIPAP)	Pressure Controlled Ventilation plus Ventilation mode for spontaneous breathing at continuous positive airway pressure with two different pressure levels
PEEP	Positive End-Expiratory Pressure
P _{insp}	Setting of the upper pressure level in PCV+
P _{Mean}	Mean airway pressure

Abbreviation	Definition
P _{Peak}	Peak pressure
P _{Plat}	End-inspiratory airway pressure
$\Delta P_{\text{supp.}}$	Set value of pressure support
PS	Pressure support
R	Resistance
SIMV	S ynchronized I ntermittent M andatory V entilation
T	Inspiratory breathing gas temperature
T _e	Expiratory time
T _{insp}	Setting for inspiratory time
T _{plat}	Plateau time
V _T	Setting for tidal volume
V _{TApnea}	Setting for tidal volume of apnea ventilation
V _{Te}	Expiratory tidal volume
V _{Ti}	Inspiratory tidal volume

Symbols

Symbol	Explanation
	Switch nebulizer on / off
	Activate/deactivate oxygenation program for bronchial suction
	Start manual inspiration and hold
	Select settings page
	Configure system settings
	Display alarm limits
	Display measured values
	Switch between flow / pressure curve
	Bright / dark screen brightness setting
	Mute audible alarm for 2 minutes
	Acknowledge alarms
	Lock ventilation parameters and ventilation mode
	Standby
	Upper alarm limit
	Lower alarm limit
	Lower / upper alarm limit
	Refer to instructions for use!
	Protection class Type B
	Protection class Type BF
	Insert flow sensor

Technical Data

Environmental Conditions 120

Settings 120

Performance Data 121

Measured Value Displays 121

Monitoring 122

Operating Data 123

Classifications 125

Materials Used 126

Technical Data

Environmental Conditions

During operation

Temperature	5 to 40 °C (41 to 104 °F)
Atmospheric pressure	700 to 1060 hPa
Rel. humidity	5 to 95 %, no condensation

During storage and transit

Temperature	-20 to 70° C (-4 to 158 °F)
Atmospheric pressure	600 to 1200 hPa
Rel. humidity	10 to 95 %, no condensation

Settings

Ventilation modes

CMV, CMV_{Assist}
SIMV, SIMV / PS
PCV+, PCV+/PS
CPAP/PS

Ventilation frequency

2 to 80 bpm

Inspiration time T_{insp}

0.2 to 10 s

Tidal volume V_T

Accuracy
0.05 to 2.0 L, BTPS*
±10 % of set value or ±25 mL,
whichever is greater.

Inspiratory pressure P_{insp}

0 to 100 cmH₂O**

O₂ concentration

Accuracy
21 to 100 vol. %
±3 vol.%
The accuracy of the inspiratory O₂ concentration is noticeably
reduced when operating Savina without O₂ sensors.

Positive end-expiratory pressure PEEP or interm. PEEP

0 to 35 cmH₂O

Trigger sensitivity

1 to 15 L/min

Pressure assist P_{supp.}

0 to 35 cmH₂O (relative to PEEP)

Flow Acceleration (FlowAcc)

5 to 200 cmH₂O/s

* BTPS
Body Temperatur, Pressure, Saturated.
Measured values with reference to the conditions in the patient's lung,
body temperature 37 °C, ambient pressure, water vapor saturated gas.

** 1 cmH₂O = 101.97 Pa

Performance Data

Control principle	time cycled, volume constant, pressure controlled
Intermittent PEEP frequency	2 cycles every 3 minutes
Nebulization of medicated aerosols (with O ₂ supply only)	for 30 minutes, in the inspiratory flow phase, 2 bar (29 psi), max. 10 L/min., Savina takes the nebulizer flow into account to keep the minute-ventilation constant.
Oxygenation program for bronchial suction (with O ₂ supply only)	
detection of disconnect	automatic
detection of reconnect	automatic
pre-oxygenation	max. 3 minutes with 100 vol.% O ₂
oxygenation during suction	max. 2 minutes
post-oxygenation	2 minutes with 100 vol.% O ₂
Supply system for spontaneous breathing and PS max. inspiratory flow	blower with quick-action pressure control valve 180 L/min
Equipment compliance (with Fisher & Paykel MR 730 humidifier and reusable adult patient circuit)	≤2 mL/cmH ₂ O
Inspiration resistance	≤2.3 cmH ₂ O/60 L/min
Expiration resistance	≤3.8 cmH ₂ O/60 L/min
Equipment compliance (with Fisher & Paykel MR 730 humidifier and pediatric patient circuit)	≤1 mL/cmH ₂ O
Inspiration resistance	≤4.1 cmH ₂ O/30 L/min
Expiration resistance	≤4.1 cmH ₂ O/30 L/min
Additional functions	
Inspiration relief valve	opens the breathing system in case of a failure
Safety relief valve	opens the breathing system at 100 cmH ₂ O

Measured Value Displays

Airway pressure measurement

Max. airway pressure	P _{Peak}
Plateau pressure	P _{Plat}
Pos. end-exp. pressure	PEEP
Mean airway pressure	P _{Mean}
Range	0 to 99 cmH ₂ O
Resolution	1 cmH ₂ O
Accuracy	±2 cmH ₂ O

Inspiratory O₂ measurement

Inspiratory O ₂ concentration FiO ₂	
Range	18 to 100 vol.%
Resolution	1 vol.%
Accuracy	±3 vol.%

Flow measurement

Minute ventilation MV	
Spontaneously breathed minute ventilation MV _{spont}	
Range	0 to 99 L/min, BTPS*
Resolution	0.1 L/min
Accuracy	±8 % of measured value
To...90	approx. 35 s
Measured expiratory tidal volume V _{Te}	
Range	0 to 3999 mL, BTPS*
Resolution	1 mL
Accuracy	±8 % of measured value

Frequency measurement

Breathing frequency	
Total breathing frequency f _{tot}	
Range	0 to 150 /min
Resolution	1 /min
Accuracy	±1 /min
To...90	approx. 35 s

Breathing gas temperature measurement

Range	18 to 51 °C
Resolution	1 °C
Accuracy	±1 °C

Waveform displays

Airway pressure Paw (t)	-5 to 100 cmH ₂ O
Flow (t)	-200 to 200 L/min

Monitoring

Expiratory minute volume MV	
Upper alarm limit alarm	when MV exceeds the upper alarm limit.
Setting range	41 to 2 L/min, in 0.1 L/min increments
Lower alarm limit alarm	when MV falls below the lower alarm limit.
Setting range	0.5 to 40 L/min, in 0.1 L/min increments
Airway pressure Paw	
Upper alarm limit alarm	when the "Paw high" value is exceeded.
Setting range	10 to 100 cmH ₂ O
Lower alarm limit alarm	when the value "PEEP +5 cmH ₂ O" (linked to the set value of PEEP) is not exceeded for at least 0.1 s in two successive ventilator breaths

* BTPS
Body Temperature, Pressure, Saturated.
Measured values with reference to the conditions of the patient's lung,
body temperature 37°C, ambient pressure, water vapor saturated gas.

Insp. O₂ concentration FiO₂

Alarm at upper limit

if FiO₂ exceeds the upper alarm limit for at least 20 seconds.

Lower alarm limit alarm

if FiO₂ falls below the lower alarm limit for at least 20 seconds.

Range

both alarm limits are automatically linked to the setpoint –
below 60 Vol.%: ± 4 Vol.%
60 Vol.% and over: ± 6 Vol.%

Tachypnea monitoring

Alarm

if the overall breathing frequency alarm threshold is exceeded during spontaneous breathing.

Adjustment range

10 to 120 /min

Apnea alarm time

Alarm

if no breathing activity is detected.

Adjustment range

15 to 60 s, adjustable in 1 second increments.

Insp. Tidal Volume

Alarm

if the applied tidal volume V_T exceeds the alarm threshold.

Adjustment range

0.06 to 4.0 L

Operating Data

AC line power

100 V to 240 V, 50 / 60 Hz

Current consumption

at 230 V

max. 1.3 A

at 100 V

max. 3.2 A

Power consumption in "typical" ventilation


typically 100 W, approx.

Ventilator fuses

Range 100 V to 240 V

F 5 H 250 V IEC 127-2 (2x)

Protection class

I, Type B 

External DC supply (on board network)

12 to 36 V DC

External DC supply (battery)

12 or 24 V

Current consumption (DC)

12 V battery

typically 10 A, max. 20 A

24 V battery

typically 5 A, max. 10 A

Backup time if AC supply is down, with charged external battery and "typical" ventilation

Examples:

12 V battery 36 Ah

approx. 4 hours (e.g. with 1 lead-gel battery 12V/36 Ah)

24 V battery 17 Ah

approx. 7 hours (e.g. with 2 lead-gel batteries 12V/17 Ah)

Backup time if AC supply is down and no external DC supply is available (new, fully charged battery)

approx. 60 minutes with typical ventilation

Technical Data

Operating Data

External Battery

Sourcing information:
Standard rechargeable lead or lead-gel batteries
can be used, e.g.

Sonnenschein	A212 / 36 A (1 or 2 batteries)
Panasonic	LCL 12 V 17P (2 batteries)
	LCL 12 V 33AP (1 or 2 batteries)
	LCL 12 V 38P (1 or 2 batteries)

Battery charging

Savina automatically detects the voltage of the
external battery connected.

Charge current:	12 V battery approx. 4 A
	24 V battery approx. 2 A

When the battery is fully charged, the charging
system switches to trickle charging.
Trickle charging is performed by short current
pulses.

Charging times

The charging times indicated refer to immediate
charging of the battery after discharge.

Several successive partial discharges without
charging from AC may extend the charging time.

Type: lead-gel batteries, maintenance-free, sealed

Minimum capacity	
12 V battery	30 Ah
24 V battery	15 Ah
Charging time	
12V battery 36 Ah	<10 hours (approximately 5 hours for 80 % charge)
24 V battery 17 Ah	<10 hours (approximately 5 hours for 80 % charge)
Charge current	
12 V battery	4 A
24 V battery	2 A

Internal battery

Type	Lead-gel battery, maintenance-free, sealed. Charging time <5 hours, also when charging from external on-board DC supply (approximately 1.5 hours for 80 % charge)
------	---

Gas supply

O₂ gauge pressure
O₂ connection thread

3 bar – 10 % to 6 bar (43.5 to 87 psi)
DISS

The gas must be dry and free from oil and dust.

Output for pneumatic nebulizer

O₂, max. 2 bar (29 psi), max. 10 L/min

Sound pressure level

(for free-field measurement over
a reflecting surface)

45 dB (A) for typical ventilation at 1 m (3.3 feet) distance

Physical characteristics

Dimensions (W x H x D)

Ventilator

380 x 383 x 358 mm (15.0 x 15.1 x 14.1 inches)

Ventilator with mobile stand

580 x 1335 x 560 mm (22.0 x 55.1 x 22.2 inches)

Weight

Ventilator only

approx. 22 kg (49 lbs)

Interface

Digital output / input

Output and input via RS 232 C interface
for MEDIBUS protocol

Classifications

EC Classification

as per EC Directive 93/42/EEC
Appendix IX

Class IIb

UMDNS-Code

Universal Medical Device Nomenclature System –
classification for medical products


17 – 429

Electrical protection classification

Ventilator

Temperature sensor AWT01 (installed sensor)

Class I

Type BF 

Electromagnetic compatibility EMC

tested to EN 60601-1-2

Materials Used

Part	Appearance	Material
Ventilation circuit (reusable)	milky, transparent	silicone rubber
Water traps	yellow, transparent	polysulphone
Y-piece with connector for temperature measurement	yellow, transparent	polysulphone
	milky, transparent	silicone rubber
Expiratory valve housing, closure	white	polyamide
Diaphragm	whitish and grey	silicone rubber and stainless steel

Theory of Operation

Ventilation Modes - Volume Controlled Ventilation	128
PCV+ (BIPAP)	134

Theory of Operation

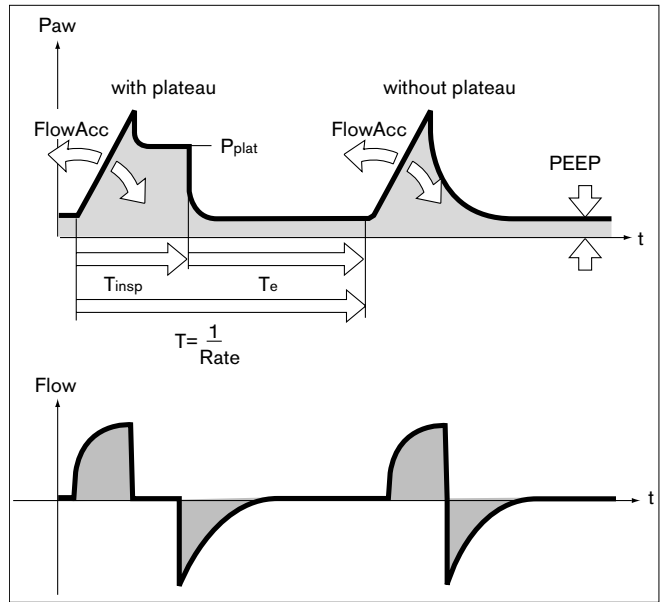
Ventilation Modes - Volume Controlled Ventilation

CMV Volume constant mandatory ventilator breaths

The ventilation pattern is defined by settings for tidal volume V_T , frequency f , inspiratory time T_{insp} , PEEP, and FlowAcc.

At the end of the flow phase, the expiratory valve remains closed until the end of inspiratory time T_{insp} . This phase, the inspiratory pause, can be identified as the plateau P_{plat} in the P_{aw} (t) waveform.

When the plateau is turned off, Savina switches to expiration immediately when the set tidal volume V_T has been applied. In this case the inspiratory time is not an adjustable parameter. It is rather the result of the compliance and resistance of the patient's lungs in combination with the set values of tidal volume V_T and flow acceleration. The resulting I:E ratio is limited to a maximum of 4:1. A minimum expiration time of 500 ms is always guaranteed



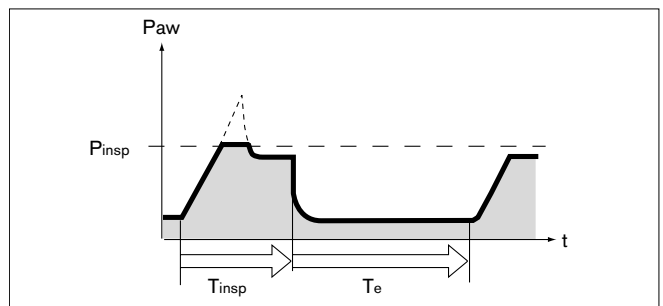
Flow acceleration

The parameter »FlowAcc« is used to influence the increase of pressure and flow. A greater value of »FlowAcc« results in a steeper (faster) increase of inspiratory pressure and flow. Flow acceleration (and inspiratory time setting) can be used for shaping the airway pressure waveform to suit an individual patient's needs.

Pressure limiting

Pressure Limited Ventilation (PLV)

Savina can limit the inspiratory peak pressure in ventilation modes CMV and CMVAssist, as well as SIMV, SIMV/PS. The »P_{insp}« ventilation parameter is used to set the limit. The value of P_{insp} remains in effect until Savina has applied the set tidal volume V_T or until the set inspiratory time has elapsed. If the set tidal volume can not be delivered, a "Tidal Volume low"-alarm will be displayed.



CMVAssist

Assisted ventilation with continuous positive airway pressure. The mandatory ventilator breath begins when the patient reaches an inspiratory flow that matches at least the level of the set flow trigger.

Based on the trigger, the actual ventilator rate may be greater than the set ventilator frequency.

Sigh (intermittent PEEP)

"Sigh", in the form of intermittent PEEP, is operative in CMV and CMVAssist modes.

The purpose of the expiratory sigh during ventilation is to open up collapsed areas of the lung, and to keep open "slow" lung compartments.

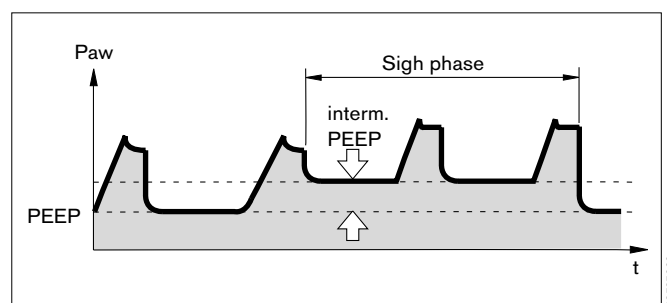
Since atelectatic alveoli have a longer time constant – also caused by obstructed bronchioli – increased airway pressure maintained over a longer period is required to open them.

Commonly, a sigh breath is achieved by simply increasing the pressure level of a ventilator breath; however, this form of sigh improves the filling of the »slow« alveoli only marginally due to the short time available.

In the Savina ventilator, the sigh operates during expiration with an intermittent PEEP. It is set as a pressure relative to PEEP (Δ sigh).

Mean airway pressure is higher, and a longer filling time can be expected.

When the sigh is activated, the end-expiratory pressure increases by the amount of the set intermittent PEEP every 3 minutes for 2 ventilator breaths.



AutoFlow®

AutoFlow can be activated in the »Settings« menu.

With AutoFlow, the inspiratory flow is automatically adjusted to changes in lung conditions (C, R) and to the spontaneous breathing demands of the patient.

Always set the alarm limit »Paw \sqrt{f} « as well as Vt \sqrt{f} in order to set off an alarm in the event of an increase in airway pressure or tidal volume Vt with change of compliance.

Typically, the selected inspiration time T_{insp} is noticeably longer than the filling time of the lungs. Inspiratory pressure P_{insp} corresponds to the minimum value resulting from both tidal volume Vt and compliance C of the lungs.

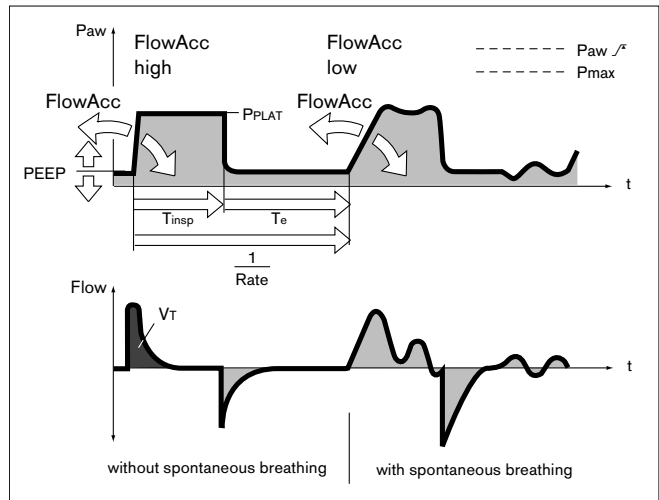
Savina automatically controls inspiratory flow so that there is no pressure peak caused by the resistances of the tube and the airways. The plateau pressure P_{plat} varies with changes in compliance C, as is normal in all constant-volume ventilator breaths. With AutoFlow, these variations occur in increments of max. 3 cmH₂O between ventilator breaths. The plateau pressure P_{plat} is automatically limited by the pressure limitation P_{max} = Paw \sqrt{f} - 5 cmH₂O.

If the tidal volume Vt is reached (inspiratory flow = 0) before the inspiration time has elapsed, the patient can breathe in and out during the remaining inspiration time at the level of the plateau pressure P_{plat}.

If the patient breathes in or out during mandatory inspiration, the plateau pressure P_{plat} is not changed for this ventilator breath. Only inspiratory and expiratory flow are adapted to the patient's demand. The individually applied tidal volume Vt may differ from the set tidal volume Vt in specific ventilator breaths, but on average over time a constant tidal volume Vt is supplied.

An excessive increase of the tidal volume Vt can be restricted by the alarm limit »Vt_i \sqrt{f} «. If the set alarm limit is exceeded just once, Savina displays an advisory message (!); if, however, the alarm limit is exceeded three times, Savina issues a warning message (!!!). The volume is actively limited to the value of the alarm threshold »Vt_i \sqrt{f} « by switching pressure to PEEP level.

A set inspiratory time T_{insp} which is shorter than the filling time of the lungs can be recognized from the flow curve: the flow at the end of the inspiratory time has not yet returned to zero. It must now be decided whether the current condition of the patient permits to extend inspiratory time T_{insp} or to increase flow acceleration, in order to apply the set tidal volume Vt.



A stenosis can also cause the filling time of the lungs to become longer than the set inspiration time T_{insp} .

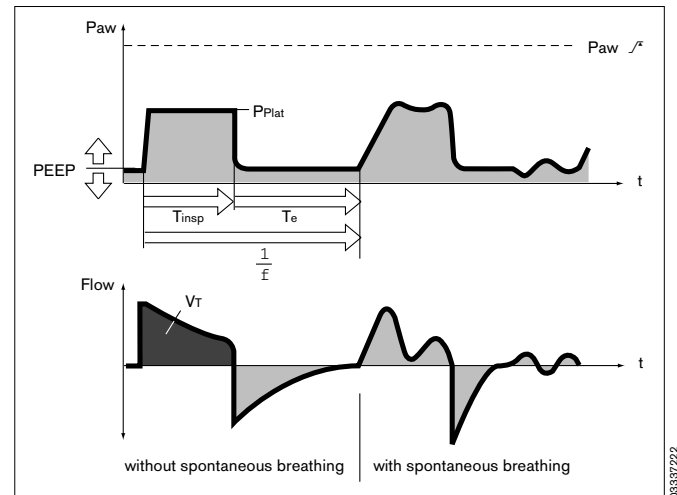
Start-up behavior of AutoFlow

Upon switching AutoFlow on, Savina applies the set tidal volume V_T using a volume-controlled ventilator breath. The plateau pressure P_{plat} derived from this ventilator breath serves AutoFlow as a starting value for the inspiratory pressure.

Settings to suit the patient's needs

The start of mandatory inspirations can be synchronized with the patient's inspiratory effort using the flow trigger parameter. Flow trigger can only be completely turned off in CMV ($\text{CMV}_{\text{Assist}}$ → CMV).

With ventilation parameter »**FlowAcc**«, the steepness of the pressure increase from PEEP level to the inspiratory pressure level can further be adapted to suit the patient's needs in SIMV and CMV.



SIMV

Synchronized Intermittent Mandatory Ventilation

Combination of mandatory ventilation and spontaneous breathing.

SIMV enables the patient to breathe spontaneously during predefined, regular intervals between mandatory ventilator breaths that ensure a minimum ventilation.

This minimum ventilation is controlled by setting two values: tidal volume (V_T) and ventilator rate. The minimum ventilation is the product of $V_T \times \text{Rate}$.

The ventilation pattern is defined by the set values of tidal volume V_T , ventilator rate, inspiratory time T_{insp} and flow acceleration FlowAcc .

To prevent a mandatory mechanical breath from being delivered during a spontaneous expiration, the flow trigger of the ventilator ensures that the mechanical breath is triggered within a "trigger window" and synchronized with the patient's spontaneous inspiratory effort.

The maximum length of the "trigger window" is 5 seconds.

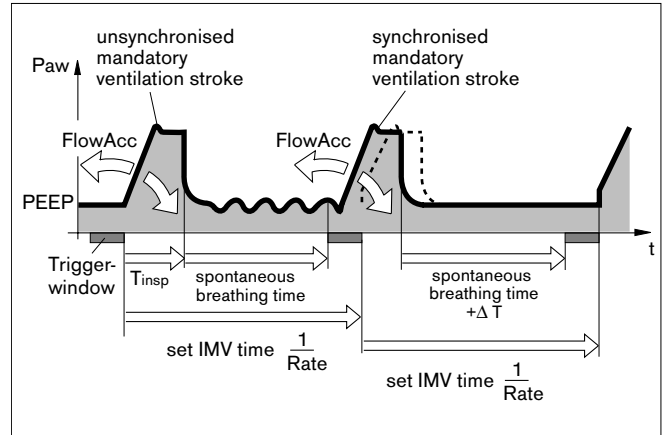
If expiratory times are less than 5 seconds, the trigger window will cover the entire time of expiration, less the first 500 ms which are reserved as a minimum expiratory time.

Synchronization of mandatory ventilator breaths by itself effectively reduces SIMV time, which would result in an undesirable increase in the effective IMV rate. Savina therefore extends the subsequent time allowed for spontaneous breathing by the missing time difference ΔT – thus preventing an increase in SIMV rate. The mandatory breathing rate f is kept constant. It is, together with tidal volume V_T , responsible for minimum ventilation.

If the inspiratory volume of the patient is considerable at the beginning of the trigger window, the ventilator reduces its subsequent mandatory ventilator breath by shortening the time for the inspiratory flow phase and overall inspiratory time. The tidal volume V_T remains constant, and overinflation of the lungs is avoided.

During the phases of spontaneous breathing, the patient can be assisted with pressure support.

In the course of weaning a patient from artificial ventilation, ventilator rate can be progressively reduced which, in turn, will increase spontaneous breathing time, so that more and more of the required total minute volume is supplied entirely by spontaneous breathing. For this purpose, the ventilator rate may be reduced down to 2/min.



Pressure support

Support by augmented pressure for insufficient spontaneous breathing.

The ventilator function for assisting insufficient spontaneous breathing is similar to that of an anesthetist manually assisting and monitoring a patient's spontaneous breathing by feeling the breathing bag.

The ventilator takes over part of inspiration, with the patient maintaining control of spontaneous breathing.

The CPAP system supplies the spontaneously breathing patient with breathing gas even during weak inspiratory efforts.

Pressure support is started:

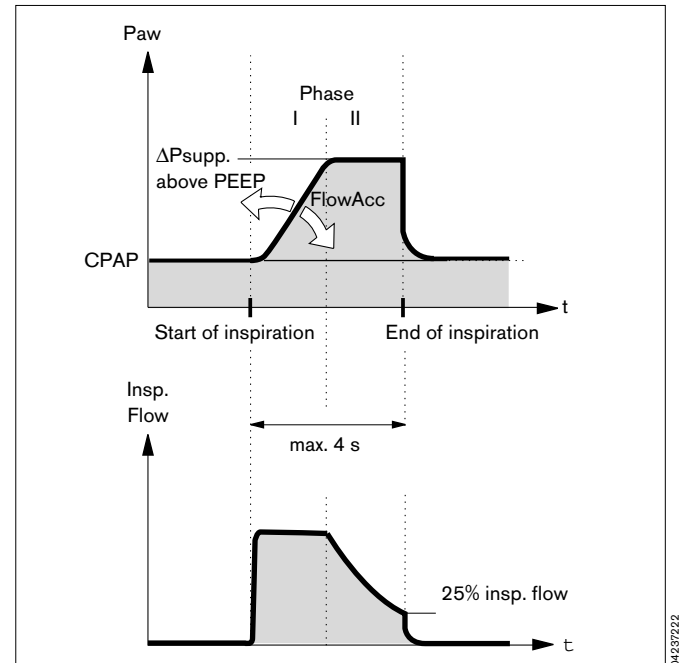
- when the spontaneous inspiratory flow reaches the set value of the flow trigger
- or, at the latest
- when the spontaneously inspired volume exceeds 25 mL.

The ventilator then produces an increase in pressure up to the preselected support pressure $\Delta P_{\text{supp.}}$ above PEEP, which is adjustable to the breathing requirement of the patient. The flow supply can be adjusted using »FlowAcc« to meet the individual needs of the patient.

- In case of high flow acceleration:
Savina supports the insufficient spontaneous breathing of the patient with a high peak flow.
- In case of low flow acceleration:
Savina begins gently with an even inspiratory flow.

Pressure support is terminated:

- when the inspiratory flow returns to zero during phase I, i.e. when the patient exhales or is 'fighting' the ventilator, or
- when the inspiration flow in phase II falls below 25% of the last inspiratory flow supplied (and therefore indicates that $\Delta P_{\text{supp.}}$ above PEEP has been reached) or
- at the latest after 4 seconds if the two other criteria have not triggered termination of the breath.
If this time criterium occurs, the advisory message **! PS > 4 s** is displayed. If this condition occurs three times in succession, Savina displays a warning message **!!! PS > 4 s** and warns of a possible leak in the patient circuit.



PCV+ (BIPAP)

**Pressure Controlled Ventilation plus
Biphasic Positive Airway Pressure**

PCV+ is a pressure controlled/time cycled ventilation mode which allows the patient to breathe spontaneously at any time. PCV+ is therefore often described as a time cycled alternation between two CPAP levels.

The time cycled change of pressure produces controlled ventilation similar to pressure controlled ventilation PCV. However, the possibility of uninhibited spontaneous breathing allows the transition from controlled breathing to independent spontaneous breathing to take place gradually over the course of weaning, without requiring any change in the ventilation mode. Both pressure level transitions (from expiratory to inspiratory pressure level, as well as from inspiratory to expiratory pressure level), are synchronized with the patient's spontaneous breathing for a good adaptation to the patient's own breathing pattern.

The overall frequency of the transitions is kept constant, even with patient synchronization, by using a fixed time trigger window.

This smooth adaptation to the patient's spontaneous breathing lowers the need for sedation, so that the patient may return to spontaneous breathing more quickly.

As in all pressure-controlled ventilation modes, the patient is not prescribed a fixed tidal volume (V_T). The tidal volume essentially results from the pressure difference between settings for PEEP and P_{insp} and the patient's lung compliance.

The display of measured expiratory tidal volume, V_{Te} , is used when setting the required difference between the two pressure levels. Any increase in this difference will cause an increase in the size of the mechanical PCV+ breath.

Changes in lung compliance and airways, as well as a patient actively 'fighting' the ventilator, can lead to changes in tidal volume. This effect is intended in this ventilation mode.

Knowing that tidal volume, and therefore minute volume, are not constant, great care must be taken to adjust the alarm limits for minute volume adequately.

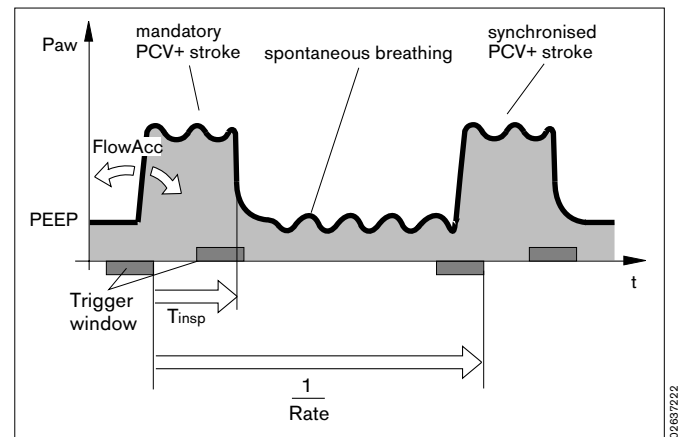
Using PCV+

As in CMV, the time pattern is set using the basic parameters of ventilator rate f and inspiratory time T_{insp} . The lower pressure level is set with parameter PEEP, while the upper level is set with P_{insp} .

When switching from volume controlled ventilation to PCV+ mode, only the P_{insp} setting needs to be changed – while retaining the time pattern.

The steepness of the increase from the lower to the upper pressure level is controlled by the setting of »FlowAcc«. During the lower pressure level phase, spontaneous breathing may be augmented by pressure support. The steepness of the increase to pressure support pressure ΔP_{supp} above PEEP is also controlled by the setting of flow acceleration.

Weaning a patient from controlled ventilation to fully spontaneous breathing is achieved by gradually reducing inspiratory pressure P_{insp} and/or ventilator rate f .



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Ordering Information

Ordering Information 138

Ordering Information

Name/Description	Order No.
Basic ventilator	
Savina	84 13 600
Options	
Option AutoFlow®	84 14 069
Option PCV+	84 14 060
Nurse call system	84 14 476
Plug for the connection of nurse call system	18 46 248
90° O ₂ connector	84 13 641
Set of side rails (for mounting accessories)	84 14 358
Humidifier accessories	
Mounting brackets (for Fisher Paykel MR 730)	84 11 074
Special accessories	
Mobile cart SavinaMobil	84 14 335
Adult size test lung	84 03 201
Column extension kit	84 13 962
MEDIBUS cable	83 06 488
DC cable for external battery	84 14 047
ext. lead acid gel battery 12 V / 17Ah (2 required)	18 43 303
DC cable S, for external on-board DC supplies	84 14 048
Consumables	
O ₂ -Sensor (Oxytrace VE)	MX 01 049
Flow-Sensor Spirolog (pack of 5)	84 03 735
Replacement parts	
Dust filter kit	84 14 057
Microfilter	67 37 545
Expiratory valve	84 13 660
Water trap	84 04 985

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Index

Abbreviations	116	Components	
Adjustment range		removing	86
standard	52	Components, assembly of	30
Advisory message	66	Condensation	12, 33
Alarm event	65	Configuration	78
Alarms	27	screen page	27
screen page	26	Configuring	
Apnea alarm time	64	measured values field	79
Apnea ventilation	62, 82	Consumables	138
Artificial nose	33	Contrast	
Audible alarm	67	setting screen	78
AutoFlow	57, 130	Control unit	112
		Controls	
		screen operating	23
		ventilation	22
		Cooling air	16, 94, 97
		CPAP	61
		CPAP / PS	61
Back panel	114	Date	83
Bacteria filter		Definitions	10
installing	31	Detergents	89
Bacteria filters		Diaphragm, expiratory valve	88
expiratory	32	Disinfectants	
Bar graph		surface	89
for pressure	45	Disinfecting	89
Batteries		Disposal	99
disposal	99	of ventilator	99
Battery		Dust filter	
external	37	replacing	97
internal	37	dust filter	97
Battery, external			
technical data	124	EMC	125
using	98	Environmental protection	
BIPAP	60, 134	when disposing of batteries/O2 sensors 16, 94, 99	
BIPAP / PS	60	Ethanol solution	88
Blower speed	44	Expiratory valve	88
Body fluids	15, 86	assembling	30
Breathing bag	44	installing	30
Breathing resistance		Explosion	
increase of	33	risk of	13, 38
Bronchial suction	73	Explosion, risk of	16, 94, 99
		Extreme settings	52
Calibrating	75	Filter	
Care	86	obstruction of	12, 32
Caution message	66	FiO2	81
Charging times, for batteries	124	Flow acceleration	128
Checklist	47	Flow Acceleration FlowAcc	55
Classifications	125		
Cleaning	89		
Clock	95		
Clock, real-time	95		
CMV	54, 128		
CMVAssist	129		

Flow monitoring	81	Nurse call system	43
Flow sensor			
installing	31		
removing	88	O ₂ Monitoring	81
Front connection block	113	O ₂ sensor	
Functions		calibrating	76
special	70	Disposal	99
		Fitting	98
Gas failure	68	O ₂ sensors	41
Grounding	12, 36	O ₂ Supply	
		connecting	42
Heat/Moisture Exchangers		Operating concept	22
Precautions when using	33	Operation	50, 73
Humidifier		Ordering, information for	138
placement	34	Oxygen enrichment	73
Humidifier, heated	12, 33		
Humidifiers		Parameters	
third party	12, 34	presetting	53
Hygiene protocols	86	Parts	
		user replaceable	96
Inspect	97	Parts washer	15, 88
Inspection	95	Patient circuit	
Inspiration		antistatic	12, 35
manual	70	connecting	35
Intended Use	18	electrically conductive	12, 35
Intermittent PEEP	56, 129	removing	86
Intrinsic (inadvertent) PEEP	33	Patient Safety	
		Operator's responsibility for	8
Keys		Patients	
for routine and auxiliary functions	24	non-infectious	91
locking	53	Phones, mobile	11, 19
Label		Plateau	57
Air intake CAUTION	115	Plateau pressure	82, 128
Main WARNING/CAUTION	115	PLV	128
Limitation of liability	8	Polarity, of battery	37
Line voltage	36	Power source priorities	38
		Power strip	
Materials used	126	precautions when using	36
Measured values	69	Power Supply, electrical	36
MEDIBUS protocol	84	Power switch	24
Medicament nebulizer	87	Power-on self test	44
Microfilter	95, 96	Preparation	30
replacing	96	Pressure limit	54
Mobile telephones	11, 19	Pressure limitation	128
Monitoring, appropriate	19	Pressure reducer	
		replacing	95
Nebulization	71	Pressure support	133
Nebulizer	12, 33, 71	Priority level	
		of alarm messages	102
		Readiness for operation	
		checking	44

Release code	84	Troubleshooting	102
Resistance		Typing conventions	10
inspiratory	12, 34		
Schedule		Values, measured	
for disinfecting / cleaning / sterilizing	91	screen page	26
Screen pages	25	Valve, expiratory	88
Selecting		Ventilation	
ventilation mode	22	minimum	132
Setting		volume constant	128
ventilation parameters	22	Ventilation modes	52, 54, 128
Settings	26	preconfigured	53
Sigh	56, 129	volume controlled ventilation	128
SIMV	58, 132	Ventilation parameters	
SIMV / PS	58	setting	52
Software version	84	Ventilator	
Solvents, organic	16, 89	using on a new patient	42
Standby	27	Ventilatory function	
Status lights		checking	45
for power supply	37	Voltage detection	38
Sterilizing	89	Volume	
Storage		adjusting	79
extended	99		
Suction	73	Warning message	66
Supply pressure		Warranty	9
oxygen	42	Waveforms	69
Symbols	118	Weaning	
Synchronization		with PCV+(BIPAP)	60
in SIMV	132	What's what	112
		Working hours	81
Technical data			
external battery	124		
measured value displays	121		
monitoring	122		
operating	123		
performance	121		
physical characteristics	125		
sound pressure level	125		
Technical safety certificate			
for heat/moisture exchanger	12, 33		
Temperature			
ambient	65		
Temperature monitoring			
proximal airway	12, 34		
Test lung			
connecting	44		
Time	83		
Time constant, of lung alveoli	129		
Trickle charge	41		
Trigger	55, 56		
activating	56		
switching off	56		
Trigger sensitivity	56		

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These Instructions for Use apply only to
Savina
with Serial No.:

If no Serial No. has been filled in by
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